APPENDIX A

ARTICLES AND SPEECHES

"Logistical Support of British Operation in Burma in the Winter of 1944-1945," by Brigadier General Walter K Wilson, Jr., Deputy Engineer in Chief, Southeast Asia Command

In the summer of 1944, Lord Louis Mountbatten and his Southeast Asia Command staff was faced with a logistical problem. The operational situation was as follows: Burma was still in the hands of the Japs. In the north, Chinese-American forces under General Stilwell were fighting for Myitkyina, the outpost of civilization in Burma in the north. In the northeast, British-Indian troops of the 14th Army were clearing the remnants of an audacious Jap offensive from the fringe of India and the northeast corner of Burma.

The mission assigned required the reconquest of Burma. The normal approach to Burma is from the south, through Rangoon All communications in Burma extend from Rangoon. Railroad lines run from Rangoon to the north up through the center of Burma to Mandalay and Myitkyina with a side line off toward China to Lashio. The mainriver communication also extends from Rangoon, utilizing the Irrawaddy up to Mandalay and Myitkyina. However, since means of amphibious operation to retake Burma from the south were not available, Southeast Asia Command was forced to plan the conquest from the north. Entering Burma from the north, the railroad lines could be reached at Myitkyina and Mandalay, but railroad lines without rolling stock are of little value. Early in the campaign, the principal rivers in Burma could be reached; the Chindwin at Kalewa and the Irrawaddy at Myitkyina, but again without powered craft these rivers furnished an unsatisfactory line of communications. Before the war, no roads connected Burma with India. American forces under General Stilwell were hacking the Ledo Road across mountains and through the jungles to Myitkyina, but by the summer of 1944, this road was still several hundred miles short of Myitkyina. On the west, British engineers had earlier improved the road from Manipur Road to Imphal and had then built an extension across the mountains to Tamu. But Tamu is over 300 miles from Mandalay and nothing but tracks connected the two.

. . . Calcutta, a teeming port, was the starting point for supplies, both for British and American forces. From Calcutta, supplies were moved by rail over a broad-gauge line for over 200 miles and then transferred to a narrow gauge for another movement of 388 miles to reach Manipur Road, including transfer- across the Brahmaputra by a rail ferry. The U.S. supplies followed this same route, but continued past Manipur Road. to Tinsukia and the Ledo area. In addition, the small port of Chittagong was connected by a narrow-gauge rail with Manipur Road, a distance of over 350 miles. Major base facilities at Calcutta were ready to handle the load, and at Manipur Road the advance base was in being. Forward from Manipur Road, an all-weather macadam road was in good shape to Imphal Jap demolitions and monsoon damage had to be repaired between Imphal and Tamu. From Tamu forward, a fair-weather track ran to **Kalewa.** East of the Chindwin River lay a broad jungle-filled plain, traversed only by little-used tracks and a narrow fair-weather road to Mandalay. From Mandalay, the main road net of Burma leads to the south. Thus, in effect, the base area was prepared, even though supply was inflexible due to the distances and transshipments required. But forward of the base an almost virgin country must be crossed by an army of two corps to reach the central plain of Burma. And even then, once Mandalay was seized, the army would still be 400 miles from its goal at Rangoon.

Aside from the war against the Jap must be considered the war against the weather. In Burma, May to November is the season of rains or monsoons. While these torrential rains do not prevent operations, they break down all communication lines, making fair-weather roads impassable, interrupting all-weather roads for varying periods, and generally forcing operations to proceed at a walk. Thus, the operation must jump off in full force in December and reach its goal in Rangoon in early May in order to insure defeating the second enemy, the weather. ...

The logistical solution presented can be summed up in a few words. Use every means available to beat the monsoon. The successful efforts by the American forces to supply Chinese and American troops of the Northern Combat Area Command have been so well covered by other articles that I will cover only the logistical support of the British 14th Army. One of the principal requirements was POL (gasoline and its allied products).

A British pipeline was built from Chittagong to Manipur Road and then extended to Imphal. The road to Tamu was repaired to all-weather classification across the mountain region. One hundred miles of new all-weather road were built from Tamu to Kalewa. Because of the time element, lack of a sufficiently large number of dump trucks, and lack of good stone sources, this road was surfaced with PBS. PBS, directly translated, means prefabricated bituminized surfacing, or, as we would be more apt to know it, heavy burlap thoroughly impregnated with bitumen, brought up in rolls and laid on the prepared subgrade. This was definitely in the nature of an experiment, but it had to work, and be ready by the next wet season. In the meantime, traffic used the old dry-weather trail. Because there were not enough engineers to do this job and also bring the Kalewa-Mandalay road up to specifications, supplies forward of Kilewa would move by the Chindwin River down to the junction of the Irrawaddy to Myingyan. Only tactical vehicles belonging to divisions used the existing fair-weather road from Kalewa forward. To implement this river supply scheme, it was necessary to get floating equipment to Kalewa. The lines of communications would not handle the large tonnages of craft in addition to the essential tonnages to supply the army, so impromptu boat yards were set up at Kalewa and hundreds of various types of barges and boats were built. Engines and special fittings were brought down the long railroad and road lines of communications to complete the job, and even a few sectional tugs made the long journey. In addition to new craft built, every type of local craft available was pressed into service. POL was moved forward by making up large rafts of drums, fastening them together with a bamboo floor, and towing them down the river. Rafts for dry storing were constructed from light materials obtainable locally, principally bamboo, and floated one-way to Myingyan.

All of this would have been to no avail without the magnificent effort of the RAF and USAAF on air supply. It can be safely said that the Burma campaign was an air supply war. Divisions would advance fifty to a hundred miles, forward engineers would know about an air-strip, and the C-47's and 46's would land, thereby increasing the efficiency of payload over that possible by air dropping. Thus in effect, the supply was by a series of hops forward to one transport strip after another with the interval covered by air dropping. The flexibility furnished by this air supply enable operations to outflank the Japs which would have been

impracticable by any other means. When operations had succeeded in clearing portions off the railroad of the central plain, locomotives were brought forward by road and river, and some were even flown in by air.

. . . statistics [show] what was involved in this tremendous logistical task, but they cannot give the true measure of the hardships and difficulties involved. The operation was a success because the fighting troops were willing to get along without supplies normally considered essential;. because when an emergency arose, air supply was able to deliver the goods on time; because thousands of troops and labor working on the often crude and elongated lines of communications kept tonnages rolling forward through every difficulty.

This solution to a difficult logistical problem is not one which others will try to follow in the future, but it is a prime example of the advantages of control of the air, of adequate air supply, and of combined efforts by every practical means to deliver sufficient supplies to the right place in time to support tactical operations. Both the British and American troops who participated can be proud of a task well done.

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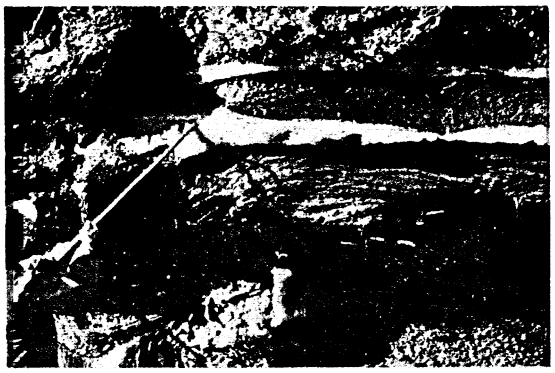

Figure 1. Horizontal Ice Ledges in the Lower Portion of a Placer Exposure

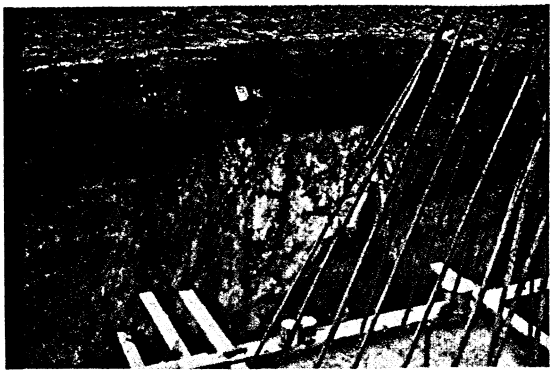

Figure 2. Concrete Foundation in Permafrost. Ice below Topsoil Layer Is Shown in Background

The Problem of Permafrost

WALTER K. WILSON, JR.
Colonel, Corps of Engineers

AN intensive study of permafrost by the Corps of Engineers, St. Paul District, under the direction of the Chief of Engineers, was started in 1945 because there had been numerous construction failures at airfields in Alaska and it was necessary to determine the best designs and construction methods for arctic and subarctic regions. The field work has included studies of airfields construction during World War II as well as an experimental plot developed at Fairbanks, Alaska for an intensive study of foundation conditions. Weather and ground temperature data are being correlated for various points in Alaska. Thermal properties of soils are being determined, and field investigations are being made to develop methods of locating the best possible airfield sites from aerial photographs. From the studies in progress, it appears that it will require several years of observations to develop design criteria and methods for construction of airfields in arctic and subarctic regions.

PROBLEMS ENCOUNTERED

Permafrost, or permanently frozen ground, is usually found in varying thicknesses below the surface of the earth in regions where the mean annual temperature is below 0 degrees Centigrade. (See Figures 1 and 2. In Figure 1, frozen peat and silt separate the ice ledges.). The permafrost phenomenon is very extensive, covering about one-fifth of the world's land area. In the northern hemisphere, permafrost is found in about 80 per cent of the area of Alaska, 50 per cent of Canada, and practically all of Siberia. Although its origin is not known, it is believed that permafrost was formed during the Ice Age. It exists as both continuous and discontinuous layers. Where it exists as continuous layers, its thickness has been found to range up to about 1,500 feet. The permafrost is generally overlain by an active zone, of which all or the upper part freezes each winter. (See Figures 4, 5, and 6.)

It has been known for a long time that permafrost exists in the regions mentioned but its effect on construction had not been studied prior to World War II, except by the Russians who have made investigations in Siberia for many years as a result of failures of structures along the Trans-Siberian Railroad. Many of the Russian studies have been concerned with obtaining basic information relative to the factors which influence permafrost, as well as obtaining solutions to various engineering problems which have been caused by disturbing the natural regime of permafrost. Their investigations, as well as our own, indicate that important factors which influence permafrost are climate, ground water, vegetation, and soil characteristics.

American engineers were confronted with problems associated with permafrost during construction of the Alaska Highway in northern Canada and Alaska. Here the permafrost, in many places, was only a foot or so below the ground surface. (See Figure 2.) Upon removal of the vegetation which is a natural insulator, the ground thawed rapidly and where fine-grained soil was present, serious difficulties were encountered in operating construction equipment. This problem was overcome, in some cases, by immediately backfilling the excavated area with sand and gravel to a sufficient depth to prevent further lowering of the permafrost surface and, in other cases, by constructing the road fill on the

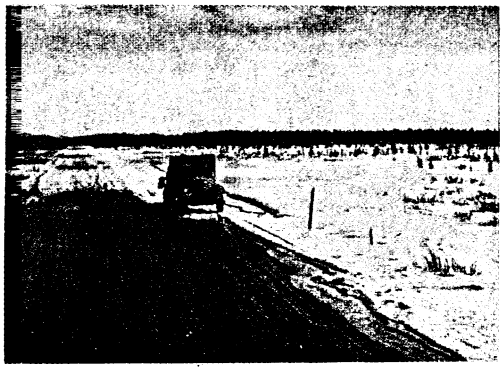

Figure 3. Encroachment of Ice Field on Highway
Note artificial thawing of ditch and culvert

natural vegetative cover. As a by-product of permafrost, drainage ditches along the highway in cut sections frequently became filled with ice during the winter season and, in many instances, the icing would overflow the roadway to a considerable depth interfering with normal use of the highway. (See Figures 3 and 4. In Figure 3 artificial thawing of ditch and culvert should be noted.) This condition was princi-

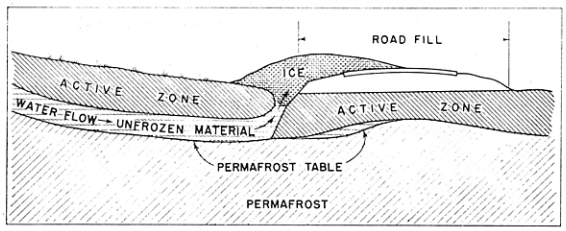

Figure 4. Uncontrolled Ice on Road

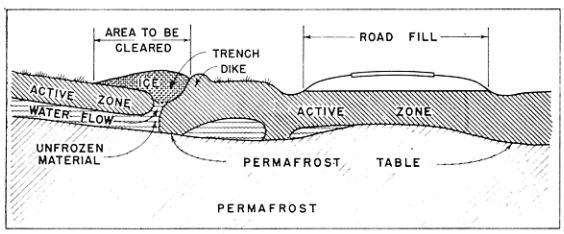

Figure 5. Method of Controlling Ice

pally caused by the seasonal freezing downward from the surface of the ground under the ditch meeting the permafrost table which forced the ground water in the hillside to break out slightly upstream from the ditch. It has been possible to overcome this difficulty to some extent by clearing the natural insulating material from a strip of land uphill from the roadway and constructing a ditch and dike perpendicular to the direction of the ground water movement to permit intercepting, conveying or storage of surface and ground water away from the road. (See Figure 5.)

The presence of permafrost also caused problems in the construction of many airfields which were built in Alaska during World War II. Problems encountered in the construction of runways were essentially the same as those encountered in highway construction. Considerable damage was caused, in some instances, where sufficient insulating material was not substituted for the natural cover which was removed and where the fine-grained frost-heaving material was not replaced by nonfrost-heaving material. As a result, the runways of certain airfields had to be reconstructed. Problems also were faced in connection with heated buildings in which conditions became progressively worse as the heat flowed into the ground over a period of time and caused the melting of the permafrost. (See Figure 6.) Where the thawed soil was fine-grained, it lost most of the stability which it had while in a frozen condition and, as a result, the buildings placed on it settled and in some cases were severely damaged.

INVESTIGATIONS IN PROGRESS

It was as a result of these failures that the investigation of airfield construction in arctic and subarctic regions was initiated by the Chief of Engineers and assigned to the St. Paul Engineer District, in January 1945. The investigation is still in progress under the general direction of the writer. It is expected that the investigation will continue for several years. The purpose of the investigation is primarily to develop design criteria and construction methods for airfield pavements, structures, and utilities located in arctic and subarctic regions. Objectives of various phases of the investigation include:

a. Study of the performance of existing airfield installations on permanently frozen ground.

b. The observation and correlation of the relationship between climatic conditions and soil conditions throughout Alaska.

c. The determination of the thermal properties of typical soils from Alaska by laboratory tests.

d. Study of heat transfer in soils and insulating materials and applications to design of runways, roads, and buildings on permanently frozen ground.

e. Review of literature in English and foreign languages on permafrost and construction thereon.

f. Development of a method of identifying permafrost areas and soil types from terrain characteristics shown in aerial photographs.

g. Investigation of the applicability of geophysical methods to use in the location of permafrost in localized areas.

Studies are now being made to attain the above objectives. Field forces in Alaska under the jurisdiction of the St. Paul District Engineer are comprised of engineers, soil technicians, temperature observers, core and churn drill operators, and surveyors.

For the purpose of determining the performance of existing airfield installations on permanently frozen ground, observations are presently being made at Northway Airfield, Alaska and, as new airfields are constructed in the permafrost region of Alaska, it is planned to make additional observations. The investi-

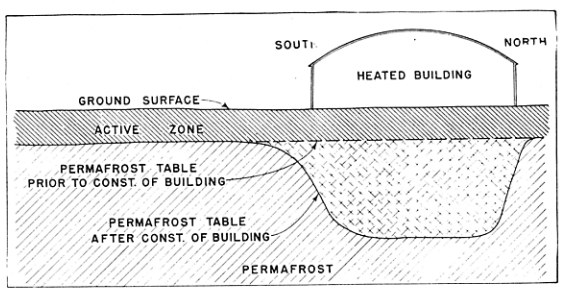

Figure 6. Effect of Heated Building on Permafrost Table

gation at the airfields includes the making of core or churn borings, with a maximum diameter of 8 inches, in the permanently frozen ground to depths of 30 to 75 feet and the installations of equipment for measuring temperatures in the boring holes at various depths below the surface. Observations of temperatures are made at regular intervals. The borings are logged and samples are tested for their physical characteristics. Ground water wells are established throughout the area and vertical movement observation points are installed along the runways and in and near structures.

From the observations made during the past two years at Northway, it is indicated that the permafrost under the runway has stabilized at a depth of about

10 feet below the surface as compared to a normal depth of about 3½ feet in the undisturbed ground. They also indicate that the permafrost surface under the hangar is receding progressively downward until it has now reached a depth of 24 feet below the floor level. Although vertical observations indicate a maximum settlement of 1 foot on the hangar floor and abutments, no apparent failure of the structure is imminent.

The investigation of the existing and proposed airfields did not provide certain basic information concerning permafrost, nor did it provide the basic information desired concerning various other types of construction. In order to obtain this information, a research area was constructed near Fairbanks, Alaska in an area of fine-grained soil where the permafrost surface is from 3 to 4 feet below the ground surface. A description of this research area is given in the article "Permafrost Research Area" by W. Marks Jaillite in THE MILITARY ENGINEER for September 1947.

As a supplement to the studies at Northway Airfield and at the Research Area near Fairbanks, an investigation is being made to determine relations between climatic and ground conditions throughout the permafrost region of Alaska. For this study, ground temperature measuring equipment was installed in 20-foot deep boring holes at each of fifteen weather stations. Observations of ground temperatures as well as climatic conditions are being made at these stations and the data collected are being studied.

Tests being made at the University of Minnesota, under a contract with the Government cover the thermal conductivity and specific heat properties of certain soils, rock types, and insulating materials at various densities, moisture contents, and temperatures. As the various reports on the tests and observations are collected from the various sources, it is planned to correlate the data, evaluate the results, and produce, if possible, guides for the design and construction of airfields in permafrost areas.

Figure 7. Aerial View of Ground Polygons

The feasibility of using aerial photographs in identifying permafrost areas on the ground is being investigated by Purdue University under a contract with the Government. From a field and office study of surface characteristics such as drainage, topography, vegetation and tree growth, as shown on aerial photographs, a technique has been developed whereby it is possible to select from the photographs, areas where construction can be successfully carried out as well as those areas which should be avoided. Figure 7 shows the pattern of ground polygons, an indication of fine-grained soil and ground ice which provide poor foundation conditions. The outlines of the polygons, as shown on Figure 7, are formed by a series of ice wedges inclosing silt or fine-grained soil areas. It has been demonstrated in the United States that studies of aerial photographs can eliminate long and extensive ground explorations where an investigation is being made to determine the most suitable site in a large area and that brief ground explorations can then confirm the selected locations.

Studies have been made to determine the feasibility of using geophysical methods for the location of permafrost. Both seismic and electrical resistivity methods have been tried and the latter method appears to have the better chance of successful application. However, the results obtained to date have not been entirely satisfactory, and it appears that further studies must be made to prove or disprove the practicability of using geophysical methods for the intended purpose.

CONCLUSIONS

It appears that it will require several years of observations in various locations and under a variety of conditions to determine thermal characteristics of permafrost areas and to develop design criteria and construction methods. Although definite conclusions can not be made at this time, there are certain trends or tentative conclusions which engineers should consider in connection with new construction in arctic and subarctic regions. These trends are based on library research and on the results of this investigation.

Site selection is very important and, wherever possible, structures should be located on coarse-grained materials where the lowering of the permafrost surface will not cause deleterious settlement of the structures.

In areas where there is danger of settlement of structures due to melting of the permafrost, a space suitable for circulation of fresh air should be provided under heated buildings to prevent the transfer of heat into the ground.

In the construction of roads and runways, no fine-grained frost-heaving soil should be permitted in the ground zone subject to seasonal frost.

Where there is danger of icing over roads, consideration should be given to cause induced icing some distance from the structure. Where possible, roads should be located to avoid side hills and incident icing problems.

Where complete information is available concerning soil characteristics and the extent of permafrost at a given site, it is possible through proper construction methods to avoid deleterious settlement of structure

The Corps of Engineers as a Career*

A MESSAGE TO STUDENTS CONCERNING THE DUTIES AND OPPORTUNITIES OF AN ENGINEER OFFICER

Foreword

The early history of the Military Academy and the Corps of Engineers were practically identical, for West Point long remained the home of the Corps. And as our young country developed westward, the rivers and canals became the highways to exploration and development, just as the frontier posts planned by the Corps and manned by the Army became the bastion of American empire.

Throughout the history of our Army and our country, engineering and construction have comprised an essential power to the support of military power. Moreover, since no other pursuit or profession so closely resembles and follows the basic principles of war as does engineering and construction, history very often records great engineers to be great military leaders in all our wars.

The combination of battle leadership, logistical leadership, and engineering technical leadership is not unique. Caesar and his Roman legions are just as famous for their fortifications, roads, aqueducts, and bridges as for their victories over the Helvetians and the Gauls. In fact, military history from the antiquity of Xerxes, through Napoleon, to the engineering and battle leadership of American Engineer officers today, demonstrates invariably the close relationship of military leadership and construction power. In considering the Corps of Engineers as a career, I cannot overemphasize the importance of this dual relationship and dual role of constituting both a combat arm and a military engineering mission.

SAMUEL D. STURGIS, JR.
Lt. Gen., United States Army
Chief of Engineers

By W. K. WILSON, JR.
Brigadier General, United States Army

AS illustrated by the SAGE BRUSH maneuver,[1] the United States must and intends to have a highly mobile Army with hard-hitting teams—which will rapidly concentrate on the objective. Then to limit hostile action, they will disperse while preparing for the next strike. Such an Army can succeed only if true leadership is active from the smallest unit to the largest. The Engineer Battalion Commander will be required repeatedly to tell his Division Commander whether or not the tactical plans can be supported. The Engineer must be certain of his position. He will need, not the slide rule certainty, but the certainty gained from a practical knowledge of what can or cannot be done, and the certainty that his company and platoon leaders will exercise ingenuity, common sense, drive, and troop leadership. The maneuver also re-emphasized that the Corps Combat Engineers are constantly working forward in the divisional areas and frequently ahead of the divisions, in river crossings, breaching minefields and, on retrograde operations, executing the last minute demolitions.

The combat mission of the Corps of Engineers is its reason for existence: to facilitate the advance of friendly troops, to impede the advance of the enemy, and to fight as infantry when required. The engineer units are organic in every division—infantry, airborne, and armor. Specifically in the forward area Combat Engineer Units ferry the advance waves in a river crossing, provide the tactical bridges for moving the forward elements, breach the hostile minefields, assist in breaching fortifications, open up and maintain the forward roads, organize the beaches in an amphibious operation, destroy bridges and facilities, lay minefields, and fight as infantry.

Behind the forward echelon, engineer functions in

*From remarks to the first class of the United States Military Academy, December 1955.
[1]See "Engineers in Operation SAGE BRUSH" by Col. J. L. Lincoln on page 120 of this issue.

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the Army team have increased in importance with the increased mobility of American forces and the increased potential for destruction available to the enemy. In order that troops and services can function, engineer missions of construction, rehabilitation, and operation must be carried out efficiently and promptly. Preparations must be made to counteract the hostile potential for rapid, far-reaching airborne attack by both static and active defense, counterattacking before the enemy can consolidate and while other elements of the combat team are being brought into the action.

Obviously, more true engineering can be accomplished as more time becomes available, but as the experiences in Korea and World War II have demonstrated, the requirement for a regular engineer officer is not for a highly skilled mathematician or design technician but for an officer with a background of technical training and experience who can furnish the leadership, broad vision, and Army technique necessary to produce military results with the skilled technicians brought into uniform during the emergency. There is a place in the Corps, as in all branches, for a true mathematician in such fields as electronics and atomic power, but the basic requirement for a regular engineer officer is that he understand the principles of construction and know how to lead men.

Missions of Air Force support give the Corps of Engineers in peace and in war the opportunity to broaden the experience of both officers and men. The Army itself gains from the concept of furnishing this support. It reduces duplication and competition for skilled personnel, provides more balanced peacetime training, and provides more flexibility and control to the theater commander in war. And the Air Force looks to the Army Aviation Engineer Battalions to provide the bulk of its combat effort in counteracting hostile ground action.

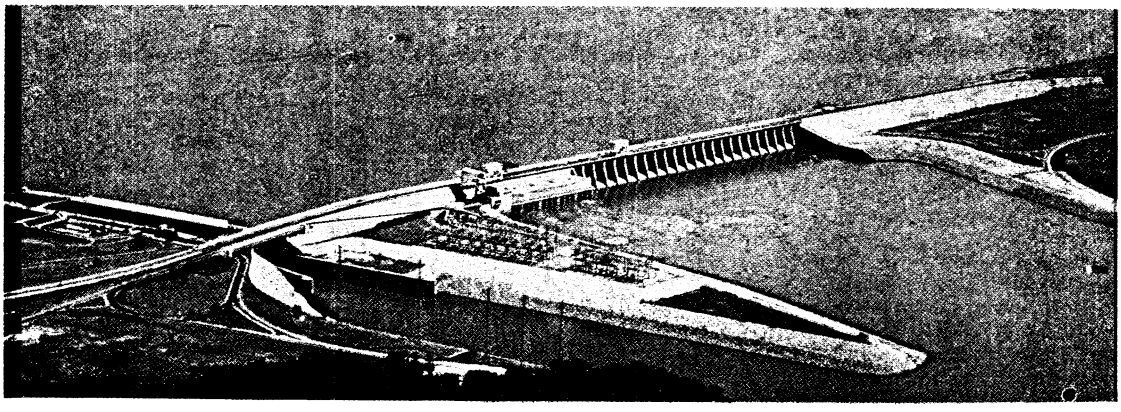
Because of the development of long range destructive weapons, America's survival may depend on her ability to maintain a "going concern" at home. The Corps of Engineers must be prepared to direct the efforts of rehabilitation in support of the war effort, without materially lessening its support of the Army and Air Force.

The successful accomplishment of these wartime missions calls for training expenditures in peacetime far beyond the financial capabilities of military appropriations. About all that available training funds provide for are individual training of the officer and enlisted man, and small unit training. Limited construction training can be added by assignment of construction jobs financed from new construction appropriations, particularly in off-shore locations, but the major source of peacetime construction training comes from the second national mission of the Corps—civil works.

IMPORTANCE OF CIVIL WORKS EXPERIENCE

Engineers of no other Army have such an opportunity and this unique mission has contributed materially to the proven ability of the Corps of Engineers to perform its function in the Army team. The normal construction struggle with men, materials, equipment, terrain, weather, and floods brings the engineer officer on civil works duty much closer to facing the conditions that confront a combat officer in war and to exercising his leadership than any other peacetime activity.

The construction organization of the Corps of Engineers is divided into thirteen Divisions reporting to the Chief of Engineers, each with several Districts. The Districts are the engineering and construction agencies, and if located in an industrial center, an additional mission of procurement is assigned. The District is normally charged with both civil works—improvement of waterways for navigation, flood control, and power—and military construction such as barracks, messes, schools, warehouses, airfields, industrial plants, and facilities for research and training—in short, all major construction for the Army and Air Force. The Engineer District plans the development of water resources of an entire region or develops the construction necessary to satisfy the requirements of a using service. It carries these projects through the preliminary stages, to detailed design and ultimately to completion of construction. This involves all types of skills—engineering, construction, legal, real estate, comptroller, administration, public relations, and personnel and job management. It requires staff planning and execution, co-ordination with higher headquarters, with the using service, with local interests, and with Congressional delegations. It often requires reinforcement of the district engineering staff



Kentucky Dam Constructed by the Corps of Engineers on the Tennessee River in Kentucky

by contracting with leading architect-engineer firms, and it normally requires contracting with construction contractors.

This construction organization provides several advantages to the Army. It gives an opportunity for engineer officers to plan and manage major projects in peacetime and develop and utilize their leadership potential. It gives these engineer officers an acquaintance with the methods and with many of the personnel in American engineering and construction industry, and it provides, in being, a large efficient organization which can be expanded and called upon to perform a major share of the missions of the Corps of Engineers in wartime. At the start of World War II and the Korean War, it was possible, without loss of time, to divert the efforts of this organization from its peacetime projects to the suddenly expanded military requirements at home, as well as to take from it technicians and management personnel required to establish major construction organizations in some of the off-shore locations.

The potential of this nation-wide organization will undoubtedly be utilized in a war of the future, not only to prepare the home base for prosecution of the war, but also to counteract at home the effects of the destructive power which an enemy may use. Even this requirement is practiced, in that the Corps of Engineers is called upon to combat floods, hurricanes, and other national disasters.[2] Thus this military-civilian construction organization is available in emergencies both in peace and in war; and, from its experience in peacetime, can develop the background which will better enable it to tackle its wartime duties.

Although of extreme importance in giving engineer officers an opportunity for practical experience in a major program, civil works involve only a relatively small element of engineer officer strength at any one time to control the fifty thousand civilian employees permanently in the organization. The bulk of the officers are in troop assignments, principally Engineer combat and combat support units. There are 5 per cent on construction; about 3½ per cent on supply and procurement; 5½ per cent on miscellaneous assignments; and 10 per cent as students. An approximately equal number, 22 per cent, is on military headquarters staffs. Troop units and direct troops support involve more than all of these assignments, or 54 per cent.

TYPICAL EXPERIENCE

The typical career of an officer currently joining the Corps of Engineers begins with the branch school at Fort Belvoir which specializes in engineer troop officer training. Then he may expect to go to an engineer unit, probably a combat or construction battalion. He can expect, within a couple of years, to have been a company commander, with the opportunities, responsibility, and experience involved. He will be dealing largely with a draft Army, most of whom want to get out as soon as they can. The opportunities for leadership will be unlimited. Both the officer and enlisted personnel have the inherent capabilities that are necessary to make a good organization and require only adequate leadership to develop. After several years of troop duty, the officer can expect to start another round of schools. Within his first dozen years of service, he can expect at least a short district tour on major construction, as well as additional Army schools, troop duty, staff duty, and perhaps a tour as an instructor.

On his first tour in the District, he will have an opportunity to make use of some of his technical training and all of his organizational and leadership training. He will find that the requisites for topnotch officers on these assignments are essentially the same as the requisites for topnotch officers in a troop assignment. He will have an opportunity to work with skilled civilian engineers; and to observe those attributes and techniques which make for a successful job. Normally, he will be responsible for some phase of a construction project, where he will be able to exercise leadership and to observe the methods of the contractors and evaluate these methods in order to determine the way he will handle a similar job when the opportunity offers.

An officer in this position should learn more in a short period of time than the average college graduate in civil life will learn in the first ten years of his experience.

After the first fifteen years, the officer may expect at least two more opportunities for important troop commands; opportunities for logistical experience and, at least one opportunity for a position at the top in either a District or Division organization. In the job as a district engineer, he will be able to put to use what he has learned in management of people, in leadership, and in technical skills. He will learn much from public relations dealings with local interests, with the contractor's management, and with the Congressional delegations in his area. In troop command assignments, he will find it necessary to get up to date on the latest changes in equipment and technique and organization in the Army, but once again he will find that the principles learned in handling people and in making an organization function effectively will be of greatest value.

While a national emergency will undoubtedly disrupt forecasting, he will have excellent opportunities for advancement to general officer grade. For example, taking the Military Academy classes of 1922 through 1932, a higher percentage of graduates who selected the Corps of Engineers as basic branch have become generals than the remainder of their Army classmates, who joined other arms and services.

OPPORTUNITIES

It is believed that officers of the Corps of Engineers are exceedingly fortunate in the opportunities for variety of service, for command assignment in the field officer and higher grades, and for having the satisfaction of watching results grow in concrete form.

In conclusion, it is well to remember that each branches the officer will have to overcome these ob- of initiative, ambition, and leadership. Every branch has its hardships, trivia, and its routine. In all the branches, the officer will have to overcome these obstacles and rise above them. If he can do so, the Corps of Engineers offers, to those who choose its service, the highest type of opportunities for military service and command. And, in addition to the military opportunities, service in the Corps offers professional training which can be a springboard to important civilian assignments when active service in the Army comes to an end.

[2]See "Operation NOAH" by Brig. Gen. Robert J. Fleming and Col. Clarence Renshaw [M.E. Nov.-Dec. 1955].

The MILITARY ENGINEER

Overseas Military Construction

By W. K. WILSON, JR.
Major General, United States Army
Deputy Chief of Engineers for Construction

THE mission of the Army has always been success in battle, and combat support remains the primary mission of the Corps of Engineers. But in recent years increasing emphasis has been placed on the provision that the preparations, so necessary to insure this success in battle, also provide the best deterrent to war.

The principal factors in insuring combat success are the soldiers, sailors, marines, and airmen, properly trained and mentally prepared to do their jobs. To potential enemies, however, the most effective deterrents are the visible forces—men and powerful modern weapons, ready and able to deliver a knockout blow if attacked. The American overseas Army and Air Force bases throughout the free world constitute a major part of such visible deterrents. The construction of these bases overseas is a mission of the Corps of Engineers.

The technical service missions of the Corps are to supply engineer materials, to acquire and manage real estate, to maintain Army installations, to conduct research and development, and to perform military construction. The overseas military construction of the Corps of Engineers today comprises bases for the Army, Air Force, and in some cases, for the Navy, and for friendly foreign governments in 23 countries: to the east in Pakistan[1], Iran, Saudi Arabia, North Africa, and countries in Europe[2]; to the west in Japan, Korea, Okinawa, Hawaii, and Taiwan; to the south in the Caribbean area; and to the north in Greenland, Iceland, and Canada. These bases are evidence that the United States is ready and able to defend the peace. They provide great encouragement and moral support to the nations of the free world.

TRANSITION FROM WAR TO PEACE

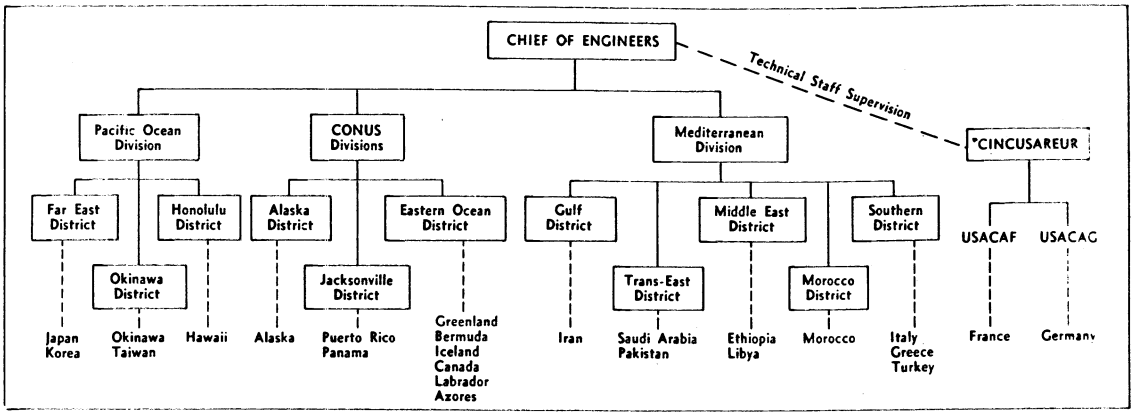
The military construction overseas also provides improved living conditions for military personnel stationed abroad. Twice since 1940 the United States has gone from peace to war, and back to a "cold war" in which the present semi-permanent overseas garrisons are maintained. Each time, at the conclusion of hostilities, soldiers have been left in scattered overseas locations, usually with inadequate barracks, little or no facilities for health and recreation, and without family accommodations. This situation has required the entire overseas command to make a transition from war to a peacetime status—from a force poised for success in battle at any personal cost, to an economical yet adequate peacetime establishment with facilities for military preparedness and proper living conditions.

In Germany, Italy, Japan, and Okinawa this transition period began in 1945, with the troops in battle positions, at the end of hostilities in World War II; it began in France in 1950, when American troops arrived to establish the Line of Communications under international agreements; and in Italy in 1955 when American forces were returned to strengthen the Italian forces. In all these areas, although work is still continuing, much has been accomplished toward providing military preparedness and adequate living conditions.

In Korea the transition began with the end of hostilities in 1953. At that time, nearly all American troops were living in tent camps under field conditions. Units were scattered as demanded by the military situation, and the Korean Government and people had little or nothing in the way of facilities which could be shared. During 1954, efforts were limited to improving the tent camps and providing the basic essentials. Since the engineer effort had to be channeled into the construction of operational and logistical facilities rather than living quarters, the tent camps were improved mostly by the men themselves, with whatever assistance the engineer troop units could give. In 1955, a program was successfully launched to provide quonset huts for living quarters. Then, in July 1956, a large-scale contract construction program was initiated to provide the necessary troop support facilities, comprising water supply, mess halls, electric power, latrines and showers, and laundry services, all on a semi-permanent basis. Subsequent programs provide for the continuation and expansion of these support facilities.

Such a transition from war to peace also requires a transition in engineer construction methods and organizations. In war, construction of logistical facili-

[1]See "Pakistan: Newest Construction Area," by Col. Robert E. Snetzer, page 335 in this issue.
[2]See "Engineers in USAREUR Today," by Col. J. E. Walsh, on page 331 in this issue.



Organization for Military Construction Overseas

ties in overseas rear areas is done almost entirely by engineer troops. At the end of hostilities, the organization, equipment, and personnel of these units must be adapted to the peacetime construction; and there are never enough units! As the transition progresses, the engineer units are usually strengthened by locally-hired civilian employees. The next step calls for employment, on a small scale, of civilian contractors, usually under unit supervision and management. Finally, in order to carry out a major construction program effectively and economically, an Engineer Contract Construction Organization is established. In addition to increasing the efficiency and control of construction management, this step also frees the engineer troop units for training in their basic combat mission. The construction transition has now progressed through this last step in all major overseas areas, Korea being the last, with the establishment of the Korea Construction Agency in 1956.

Since 1950, overseas military construction under cognizance of the Chief of Engineers has totalled over $4 billion, approximately one-third of the total military construction work during that period. When one adds to this volume the problems inherent in language differences, various national customs and construction methods, and foreign governmental policies and procedures, an appreciation of the scope of the program may be gained.

DEVELOPMENT OF CONSTRUCTION ORGANIZATION

Since 1824 the divisions and districts of the Corps of Engineers have conducted an engineer construction mission in the United States known as Civil Works, which comprises the improvement and maintenance of rivers and harbors for navigation and flood control, and the provision of multiple purpose facilities. Prior to World War II, military construction of post facilities was a responsibility of the Constructing Quartermaster, with fortification work being done by the Corps of Engineers.

Just prior to the entry of the United States into World War II, all Army military construction was made the responsibility of the Corps of Engineers. When the need for overseas contract construction became apparent, the engineer divisions and districts, well established, organized, and trained through their long and varied experience in their dual civil-military role in the United States, served as a guide for the establishment of the overseas construction agencies.

After World War II and with the advent of the "cold war," the construction programs in the Far East and Europe were executed by "Construction Commanders," with the Chief of Engineers exercising technical staff supervision only. The construction commander in the Far East was the commanding general, Army Forces Far East and Eighth Army, with construction outside Korea actually supervised by agencies similar to the engineer districts. In Korea supervision was by troop units. In Europe, the American commander in chief was construction commander, with actual construction carried out by the commands in Germany and England and elsewhere by the Joint Construction Agency, which, with its districts, was similar to an engineer division in the United States.

Last year, as the overseas construction program began to taper off, it became apparent that certain economies could be achieved by revamping the construction organizations both in Europe and the Far East. The situations were studied and plans were made which culminated in the present construction organization in those areas. This reorganization accomplished three things:

First, the Chief of Engineers was assigned the responsibility for military construction in the Pacific-Far East area. A new division, the Pacific Ocean Division, with three districts was created with headquarters in Honolulu. The Okinawa District, responsible for construction in Okinawa and Taiwan, was taken over as one of them. A new district was organized with offices in Honolulu, responsible for construction in the Hawaiian Islands and Johnston Island. The Far East District in Seoul was made responsible for Korea and the remaining work in Japan. In some of these countries, the Corps of Engineers executes military construction for the Air Force and Navy as well as the Army.

Secondly, construction responsibility for all three services in Italy, Greece, and Turkey was transferred to the Chief of Engineers; the Southern District, with headquarters in Leghorn, Italy, was transferred from the Joint Construction Agency and placed under command of the Mediterranean Division. The Mediterranean Division, which moved its headquarters from Morocco to Leghorn, also commands the Middle East, Morocco, Trans-East, and Gulf Districts.

Third, in France, Germany, and Great Britain, where construction for the United States Military Forces is actually contracted for by the host governments, the United States Army Construction Agency, France (USACAF),[3] and the United States Army Construction Agency, Germany (USACAG), have been established, under the commander in chief, United States Army, Europe (USAREUR), to execute the construction in those countries for all three services[4], while the Third Air Force, acting for all three services, continues to place construction contracts in England with the British Government.

It may be seen that there is an important and basic difference between the duties of the Corps of Engineers and those of the other technical services. In their overseas responsibilities, only the Corps of Engineers has to move its operational force to the overseas area, set up its basic accommodations, and perform such a large-scale mission at the site. Often the Corps cannot manufacture or collect materials in the United States and fulfill its purpose by shipment to the sites. And often the construction must be done in the most primitive areas under the most adverse weather conditions, and in a limited time. For example, at Thule, Greenland, a remote snow-and ice-covered Arctic site, the minimum operational portion of this major air base was completed within four months after construction was started.

[3]See "Construction Progress in France," by James S. Arrigona, on page 333 in this issue.
[4]Described in articles immediately following.

FUTURE NEEDS

Present indications are that progress in the technology of war will increase rather than decrease the logistical requirements for construction. The development of ballistic missiles, atomic explosives, and the means of defense against them, as well as the new political-military programs such as Mutual Security, creates new challenges to the military engineer in his construction mission. The increased requirements must be met with additional and widely dispersed installations, increased efficiency of construction operations, maximum use of indigenous construction capabilities, and the development of new construction methods, materials, and equipment in co-operation with the construction industry.

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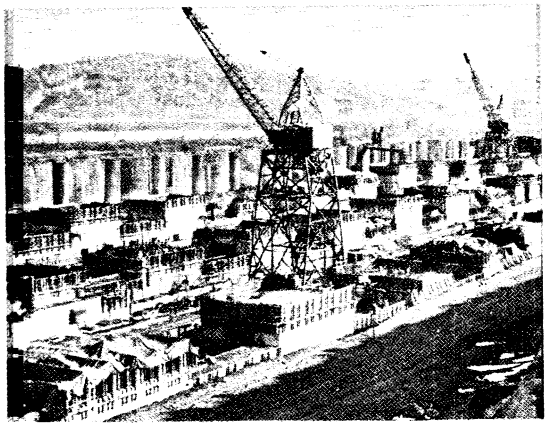
The Military Engineer as Engineer-Manager

By LT. GEN. WALTER K. WILSON, JR.
Chief of Engineers, United States Army



Concrete Work at Belleville Locks, Ohio River

DURING the past decade, military engineers have been challenged by larger and more complex projects than in all the history of the profession. High among them were the design and construction of the first missile pads at Cape Kennedy (then Cape Canaveral) and at Vandenberg Air Force Base, the rocket test stands at Huntsville, the Zeus facilities at White Sands and in the Pacific, and the first operational ICBM launchers on the western plains.

Not so many years ago, the engineer's role in the military was comparatively simple. The military engineer was mainly concerned with the attainment of military objectives in the combat areas. His work had little connection with the technology that influenced economic or scientific progress. Specifications for construction work by the Army Corps of Engineers in 1875, typical of the time, read:

> To be constructed of flat rubble stone walls in the lime mortar. Rough plastered inside. Main roof timbers dressed and chamferred on corners for trusses. Rest of roof sawed, not dressed. Timbers oiled. Remainder whitewashed. Windows to have rubble arched heads . . . stone quarried and erected with lime burned at Sill by extra duty labor.

By comparison, here is a sample of what an engineer supervising construction on an ICBM base has to contend with today:

> Liquid oxygen and liquid nitrogen systems shall be judged clean when the particle size does not exceed 150 microns; total solids picked up in a component shall not exceed 75 ppm by weight after evaporation and the total hydrocarbons shall not exceed 75 ppm, including no more than 2 ppm polyacetylenes.

INCREASED DEMANDS

Military engineers today, exemplified by members of The Society of American Military Engineers—in uniform, civil service, and private practice—must know much more than those of a decade ago. For more than a generation, military requirements have forced great technical advances which in turn have been of great value in the over-all development of the civilian community. The military aircraft, with its increased speed, range, firepower, and weight, is a noteworthy example. In rapid succession came radar, atomic power, and the guided missile.

The demands upon the military engineer consequently increased. Today, he is deeply engrossed with his civilian counterparts in many problems ranging from the use of satellites for collecting geodetic data to the use of sonic pile-driving equipment. Except in the primary mission in direct support of military ground combat forces, the line that distinguishes most military engineers from those who practice engineering in civilian life—especially in the field of construction and civil engineering—is very fine. In many cases, their efforts have been completely merged as private engineering firms and military engineers work together to get the jobs done.

The diversity of the military engineering profession is growing, particularly in the activities essential to land, air, and sea operations. One such essential activity is military construction, most of it not on the battlefields or in the communications zones or anywhere near them. For example, the big Strategic Air Command bases are thousands of miles from their potential targets. There are the Ballistic Missile Early Warning Systems, and the DEW Line stations guarding the Arctic approaches to the continent, and across the country the ICBM launcher bases. Almost every type of structure is needed—navigation aids, naval bases, air bases, flood protection and other water resources works, training facilities, research, development, and testing laboratories for materials, instruments, and weapons systems, and a variety of equipment and supply facilities. And in addition, the military engineer is being called upon to help to engineer and build a way to the moon and to conduct studies that will enable lunar explorers to collect useful scientific data and information.

TEAM CO-ORDINATOR

As new goals emerge, there is increasing complexity in the tasks, requiring diversified knowledge and skills not found in any single group of engineering specialists. Many of these tasks are so large, so intricate, and so demanding of technological knowledge that they can be conducted only by teams of specialists from the various technologies working closely together under a single co-ordinator or engineer-manager.

In these team tasks the military engineer is finding that his training and experience fits him ideally for the engineering manager role. It can be seen in the Army Corps of Engineers organization and among its contractors how the military engineer is being cast more and more into the role of a manager for deploying large groups of specialists required for major projects. This demand is adding greatly to his responsibility—to what he has to know and to what he is able to do. As the engineer-manager he is the "key" man in the new engineering system. The engineer-manager is an accepted role in the missile and

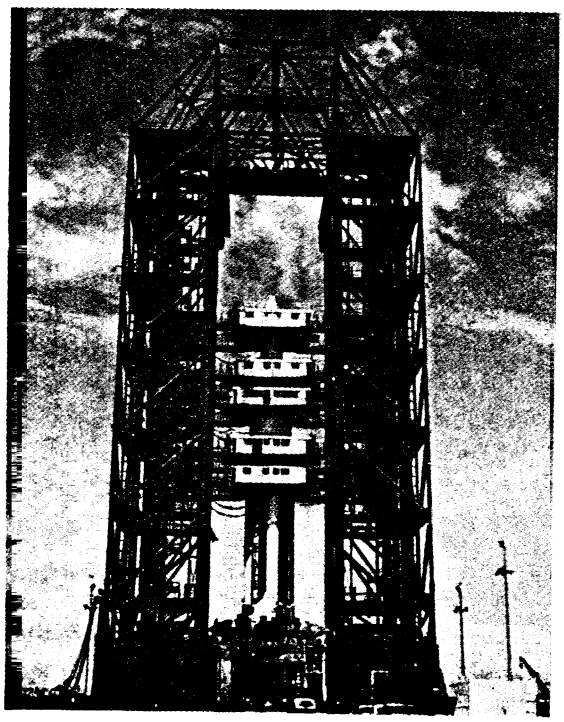
space programs and in water resources development.

Many of the most capable engineers in the military services are lending their efforts to the NASA manned lunar landing program (Apollo). Some are engaged in developing the long-range rocket engines that will push vehicles into space, while others are designing and constructing the ground support facilities for the testing and operational phases of project Apollo.

The bulk of the current space program is being conducted at four centers: the spaceport at Cape Kennedy; the new Manned Spacecraft Center at Houston, Texas; the Mississippi Test Operations Center near New Orleans; and the Marshall Space Flight Center at Huntsville, Alabama.

The biggest part of the space job is Saturn Complex 39, the launching base at Cape Kennedy. This will be the largest single space project ever constructed. The engineers have started construction on one of its elements, the vertical assembly building, 690 feet long, 510 feet wide, and 524 feet tall. It will have room for four, later six, 350-foot space vehicles to be erected and checked out simultaneously. The doors will be 450 feet high, and require the design of special mechanisms to open and close them. This building, erected on piles driven some 160 feet to bedrock, is being designed to withstand a hurricane. Other facilities undreamed of a generation ago are booster test stands at the Mississippi Test Operations Center being built to hold down engines capable of developing 7,500,000 pounds of thrust, and at the Houston Center, revolving laboratories for training the crews, and installations to simulate on earth the conditions found in space and on the moon. The largest environmental test facility will enable NASA to subject the Apollo spacecraft to a near vacuum, solar radiation, and temperatures ranging from 320 degrees below zero Fahrenheit to 260 degrees above. One of the laboratories, a high centrifuge, will revolve at various speeds to simulate the conditions of gravity and flight mechanics which an astronaut may encounter in space.

Gantry-Missile for Saturn Complex 34



Nearly every vocation in engineering has a place on the space construction team along with some other technological specialties probably not yet in existence. The construction engineer is the team captain on these big projects.

The teamwork concept is also employed in the Corps water resources program. An enormous number and variety of engineering and technological skills are required in these operations. Planning for integrated river basin development not only requires engineers, hydrologists, geologists, and economists on the team, but also other professionals such as archaeologists and biologists. Again, the role of team coordinator falls to the military engineer.

The military engineer is not only expected to manage the widely assorted construction and maintenance tasks of the Armed Forces, but also he is often asked to manage projects in other Government programs.

MANAGEMENT METHODS

Efforts are being made to fulfill this role by using the best management tools available, by using systems that permit planning and scheduling on projects so that the right material is in the right place at the right time, and so that the status of a project can be known at any time.

The military engineers are abreast of the profession in the use of modern management methods. They have been using computers for years in compiling mapping data, predicting floods, establishing supply needs, and for a variety of other tasks. They are familiar with the currently available systems that enable the engineer to lay out an entire construction job and then schedule its phases by an electronic computer.

For example, the Critical Path Method (CPM)[1] is being used in scheduling construction for the development of the Arkansas River Basin. CPM is one of the several relatively new systems for maintaining positive controls in dealing with the problems of construction sequences, schedules, and costs. These systems take the guesswork out of scheduling. The engineer-manager bases his scheduling for a project on various sets of circumstances and data that are programmed into a computer, which digests the whole plan and produces a realistic timetable. If conditions or circumstances change, the manager can evaluate these changes and readjust his schedule accordingly.

Military engineers must be the proponents of better engineering management. They must continue to seek better systems, better ways of analyzing and evaluating, and more ways of utilizing modern equipment. As engineers, they should welcome these responsibilities. They must stimulate confidence in the ability of engineers to get the job done—wherever it is and whatever it is. Through them the stature of the engineer may be enhanced. They must employ the most modern management techniques so that assigned jobs can be accomplished in a competent, economical, and efficient manner.

The ability of the United States to maintain a strong defense and a high standard of living, while helping other nations to keep their freedom, may depend upon the manner in which military engineers perform the duties assigned to them.

[1]See "Construction Scheduling with CPM," by Capt. Richard S. Kem [M.E. Nov.-Dec. 1962].

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Vision, Vigor, and Victory on the Arkansas

A Speech Before the Arkansas Basin Development Association
Little 'Rock, December 11, 1961

To begin my remarks by saying anything but "thank you" would be most unappreciative of the welcome you have given me. I know that some of you have come long distances to be here tonight. Your presence reflects the interest and drive behind the development of the Arkansas River Valley.

Soon after I became Chief of Engineers, somebody asked me if I was familiar with the Arkansas Basin Project. I replied that I was quite aware of it. It's like my golf handicap. It's big, its important, and I get reminded of it regularly. Some of you in this room see to that.

At the risk of having your chamber of commerce bill me for membership dues, I must remark that the future of the Arkansas Valley is exceedingly bright. With our country entering a period of phenomenal growth, it seems logical that this valley is an ideal place for economic expansion of all kinds. It is rich in resources, abundant in economic opportunity, and is well on its way with river basin development to support the kind of life we cherish in this country.

With 1970 as the date for expedited completion of the Arkansas Basin Project, a challenging pace has been set for this development. To help make this possible you have mobilized two human qualities essential to real progress of any basin. These are vision and vigor of the kind that built this nation. Hold on to them, and your Valley will blossom as few others have done.

One of the best descriptions of the vision that foresaw the possibilities of developing the Arkansas is a book published not long ago titled LAND, WOOD AND WATER> I believe the author comes from the Oklahoma part of the Valley, but it is good reading in Arkansas, or anywhere else where people want to move ahead. That book tells of the long struggle to convince the doubters and the apathetic - though it is hard for me to realize there were ever any of them down here- that something could be done to make the vision a reality. Bulldog persistence and the united drive triggered by the disastrous 1943 flood which paved the way for authorization of the multiple purpose plan for the valley are all a part of the story.

These things are familiar to you, but I feel they should be mentioned. For they reflect the enthusiasm and the faith you hold for the future of your valley, and your Willingness to put out the effort and investment to realize its destiny. This is vitally important to our ability to speed construction of the engineering works to conserve the waters of the Arkansas River system and put them to beneficial use.

That the multiple purpose plan is moving fast is only partly evident when you fly over the valley.For you do not see the extensive planning and other hard work that had to be done before the first earth could be moved. But a few routine facts will serve to measure progress.

The more than $80 million appropriation this year will bring the bank stabilization and channel rectification work to about 40 percent completion. It will advance Dardanelle Dam to about 30 percent completion. Oologah is almost finished. Keystone and Eufaula will be well over half complete - where complex relocation problems have been solved and for which the State of Oklahoma deserves great credit for its cooperation on highway betterment.

Last year recognition was won for bank stabilization as an integral part of the over-all plan - not just an emergency patchwork where the river was doing the greatest damage. This year a vital step was taken with the appropriation of initial design funds for navigation locks and dams.

In step with the timetable for completion of the Arkansas River Waterway are the terminal and transfer facilities being planned along the route. In the State of Arkansas, Little Rock, Pine Bluff, Van Buren and Gillett have created port authorities, and other communities are making plans to do so. In Oklahoma, Muskogee has organized its Port Commission and Tulsa is moving on such a project now, as are other cities.

This is foresight. This is drive. There will be great opportunities in the areas close to the waterway, but its effects will not end there. It will be felt hundreds of miles away. The commerce that will move to market by water transportation will not come from just the immediate area, nor will the incoming goods stop at the river bank.

When the first towboat whistles are heard, as sections of the waterway are opened to commerce, there is evidence

that you mean to be ready for business. And I am confident that in the meantime you will have gone out and gotten it and that new plants and business houses will be firing up their production lines and opening their doors with great frequency.

Not only the Arkansas, but the White and the Ouachita basins are headed for better things because of their navigation possibilities. Barge service has been reopened on the Lower White River recently, where channel maintenance has been resumed. Further improvement of the channel on the Ouachita has been authorized. These neighboring developments will be complementary to the economic rise of this great section of the United States.

Once your Arkansas waterway is opened, you will become a part of an extensive industrial complex served by barge transportation throughout the Greater Mississippi Valley, which is growing by leaps and bounds. Your interests, of course, will be served by the health and vigor of the entire system. One of the significant trends in waterway development is recognition by the respective areas along them that the bigger the whole pie becomes the more each particular community will have to enjoy. In the united effort of all concerned we gain great strength to push forward vigorously with waterway improvement in all areas.

Great as our progress with waterway development is, we have seen only the beginning of the significance of barge transportation to national advancement. It is interesting to note that we have recently found the waterways to be essential even to the Race for Space. The National Aeronautics and Space Agency, in asking the Corps of Engineers to build their new facilities for developing, testing and launching Space Rockets have emphasized the necessity of locating these facilities on the waterways. For the huge rockets exploring Space will be much too large for practicable and economical transportation by any other means than barge. Linking the various research, production, testing and launching facilities together by waterways will enable the huge boosters to be moved from point to point as required.

Much has been said about the effects of water transportation, and about other benefits that will flow from the development of the Arkansas. However, I want to emphasize the importance of making full use of recreational opportunities. These, of course, occur on the reservoirs, and are inherent in the slack water pools between the locks and dams. You can visualize a continuous water surface 450 miles long - a fabulous

addition to the present attraction the Arkansas Valley holds for recreational use by large numbers of people. Andt I might add, for the economic benefit of those who invest in facilities and services to enable the broad enjoyment of this valuable resource.

I am mindful of the accomplishments already in being and am confident you are not overlooking further progress of this kind. Certainly, the Corps of Engineers desires to work as closely as we can with respect to the recreational and fish and wildlife aspects of river development, as well as in other fields of activity.

I want to stress, too, the importance of looking ahead with investigations of future projects to be authorized and built along our way towards the ultimate full use of the waters of this basin. We have many surveys in various stages of progress for new or improved developments in Arkansas, Oklahoma and Kansas. We must push along with them, in addition to the construction of works now under way, or authorized. For they, too, are essential to your future.

Time will not permit me to discuss them here, but I do want to point out one of special significance- the study for possible control of salt pollution of the Arkansas and Red Rivers. The Public Health Service, as you are aware, has done an outstanding job in locating the sources of contamination. Now we need to ascertain the best methods of control and what they will cost. The control of salt contamination would provide water quality in Keystone reservoir and in the Arkansas acceptable to Public Health Service standards for domestic use, and acceptable for industrial and agricultural purposes. A feasible way to do it must be found.

We have a double objective on the Arkansas. One is to plan and build towards the full, comprehensive utilization of your water resources. The other is to use such development as a means of supporting President Kennedy's desire to accelerate the national economic growth rate.

The reasons are compelling. As the President stated in his Natural Resources Message to the Congress last February, wise investments in resources development programs today will return vast dividends tomorrow; whereas opportunities to carry out such developments may be lost forever if we fail to act now.

Further, the Senate Select Committee on National Water Resources and the Senate Appropriations Committee have both recently stressed the need to expand and expedite water resources development.

I am confident that the growth potential of this country can absorb the best efforts all of us can make to these ends. It requires that we apply these efforts wisely and unremittingly to achieve the dynamic progress of which we are capable.

It has become necessary that the planning and construction of projects and systems of projects be comprehensive in scope, extremely far-sighted in depth, and a cooperative undertaking among all groups and organizations concerned, public and private. The perspective of all persons engaged must be broadened, procedures sharpened and efforts intensified.

The Corps of Engineers approaches its part in these tasks with keen interest and confidence, and a sense of opportunity. We are reshaping our efforts along lines that will enhance its responsiveness to current and long range needs. One of the steps I have taken is to direct that water resources development be employed as an effective tool to stimulate economic growth. Another is to take into account the full, realistic life of water resources structures in determining their justification; and not to stop at an arbitary 50-year life.

We are seeking new ways to bring all project values into focus when they are significant to the need and the justification of a development plan. Some values are difficult to measure in cold dollars and cents but nevertheless they must be taken into account ifwe are to make the best use of opportunities to stimulate economic advancement.

I want to stress that it is my intention that the work of the Corps of Engineers be as responsive to your needs and aspirations as men can make it, both in your own interest and to the benefit of the entire country. For the progress of water resources development in your Valley is a matter of major national importance.

In closing, I want to stress that it is extremely gratifying to work with you towards the fullest realization of the great potentials of the Arkansas River Basin, and your ambitions to capitalize upon them.

I thank you.

Water Resources Development and National Defense

A Speech Before the National Rivers and Harbors Congress
Washington, D.C., May 18, 1962

You have dealt generously in giving me this opportunity to talk about water-resources development and national defense. It is a happy occasion when a man gets a chance to expound in public *on his favorite subject. National defense has been my career since entering the U.S. Military Academy and water resources have occupied a large share of my time since entering the Corps of Engineers upon graduation.

One soon learns, in the Corps, that water development and defense are two sides of the same coin. The nation's military strength is inseparable from its economic strength; its economic strength in turn depends upon the wise use of natural resources; and among natural resources, the conservation and control of water are absolutely basic.

Thus broadening and acceleration of water development of all kinds becomes a matter of primary national importance, which President Kennedy has stressed twice in his Messages to the Congress during the past two years.

What this country needs now, and needs badly, is fuller realization of the great scope and size of the water-resources development task confronting it, and an absorbing dedication to an all-out generation-long, water development effort.

How big is this task? I am going to cite some figures, derived in part from studies inspired by our work with the Senate Select Committee on National Water Resources a couple of years ago. I shall put them forward very tentatively, because of looking far ahead as we have to do in planning large-scale construction programs--the estimates of needs must necessarily be very rough.

Resources for the Future, Inc., made a monumental study for the Select Committee which indicates the magnitude of the reservoir storage capacity we shall need just to keep the rivers flowing adequately to meet all demands for water. The Corps of Engineers has completed the picture by taking into account a nationwide inventory of additional needs. The outstanding conclusion reached by combining the results of the two studies is that by 1980 - only 18 years from now - the nation will need to

add more than 400 million acre-feet of reservoir capacity to its existing systems. This is two and one-half times the capacity of all the reservoirs the Corps of Engineers has built in the past - mainly in the last two decades. And it somewhat exceeds the aggregate capacity of all reservoirs that have been built in the United States since its beginning.

And this is only the basic part of the job - necessary to provide the high degree of conservation of water and control of streamflow to assure dependable supply for such requirements as domestic and industrial use and to maintain satisfactory stream conditions generally. Add to it the navigation improvements, local flood protection works, hydro-electric power, recreation and other related tasks of comprehensive development and the over-all undertaking looms quite large.

When we in the Corps of Engineers try to size up our projected part of the task we find ourselves contemplating programs in the next two decades ranging from $1-1/2 billion to $2-1/2 billion a year for new construction alone.

Figures like these are startling. But when we look realistically at our national future, the scale of the projected development to meet water needs falls into proportion. The United States faces a big future--big in every aspect--big in strength, big in accomplishments, and therefore big in its needs.

To meet these needs, as we see them now, would require a Corps program growing at a rate of about 6 percent each year. As a national goal is an annual growth rate of at least 4.5 percent for the Gross National Product, and as attainment of this goal depends upon prior development of basic natural resources, a growth rate of at least 6 percent in developmental programs appears entirely reasonable. Moreover, we have some catching up to do in the developmerit of water resources.

We have made an analysis of how the demands projected by various authorities for the Senate Select Committee would, in all probability, affect those parts of the over-all water resources responsibility to which the Corps of Engineers' efforts are normally directed. Our concern has been to ascertain where we have to raise our sights, how we need to sharpen our procedures, and in general, line our work so as to make headway towards helping meet future requirements.

I might add that we were interested in finding out where any bottlnecks might be encountered, so we might take early action in an effort to avoid them.

Beginning with the reservoirs, let me pass along to you some of the facts our analysis revealed. The Senate Select Committee's report indicated that a total of well over 300 million acre feet of reservoir storage space would be needed by 1980. This storage was projected just for regulation of the nation's rivers to increase low water flows for purposes such as water supply, water quality control, power, navigation, recreation and the like. Additional storage reserves for flood control, most of which would be combined in the same reservoirs with water supply, would also be needed, making the total requirement about 400 million acre feet of reservoir capacity.

Our estimates indicate that the Corps of Engineers should be prepared to build about 3/4 the total storage requirement, and that the cost would be something like $15 billion, figured at 1960 dollars.

Now where is the space to store this water effectively and economically to come from? In many respects, this is going to be a harder problem to solve than that of expanding the capability to build the reservoirs, or finding the money to pay for them. I think we will have the construction capacity, all right, but we will have to find many more able planning engineers to carry out programs of the magnitude indicated. I don't want to minimize the money - but if we've got to have the water, the question boils down to the hard fact that we've got to get it, through reservoir construction, and do it at the cheapest cost we can. But as to land on which to store the water, that is something else again. In some of our river basins, such as the Ohio, for example, the amount of feasible reservoir space which can be acquired without major disruption of existing development such as communities, highways, industries, railroads and the like, is nowhere near adequate. And it is getting less every day. This is one of the aspects of the water resources job where the country is going to feel the pinch of the lack of enough highly capable and experienced planning engineers who can help us store the most water for the least sacrifice of either land or money.

Even when all these problems are solved--money, planning, capability, space and efficiency--we still will face the

problem of time. If the challenge is to be met, and if construction programs of the scale we are talking about are to be carried out within only 18 years, we must start working on them much faster and quite soon.

To meet Federal flood control responsibilities properly, the multi-purpose reservoir program should be supplemented by about 11,000 miles of levees, floodwalls, channel improvements, and related works costing about $2 billion. Also, some 3,000 flood-plain studies, costing about $80 million, should be undertaken to encourage local regulation in effort to minimize the flood risk and reduce the cost of building protection for property that should not be located in the flood plain.

Meanwhile, the augmented reservoir program would make feasible the installation by 1980 of about 33 million kilowatts of new power-generating capacity, costing over $5 billion.

Any forecasts must recognize the phenomenal increase in the public demand for water-based recreation. In 1961 the attendance at Corps of Engineers reservoirs alone totalled about 120 million. Fifteen years earlier it had only been about 5 million. In view of this growing demand, and in anticipation that new reservoirs will continue to be built and will be better adapted for recreation than older ones, an estimated 300 million attendance by 1980 is conservative.

We believe that the state and local entities should be encouraged to develop the recreational potentialities of Federal reservoirs to the greatest possible extent. However, the Federal Government can and should acquire land for recreational development at reservoir areas and should also provide such basic facilities as access roads, picnic grounds, boat-launching ramps, sanitation and the like. We contemplate that perhaps $700 million might be spent for such purposes at Corps projects by 1980.

The national inland-waterway system embraces some 20,000 miles of improved channels in commercial use. We have estimated that 10,000 miles of these channels need improvement, and about 1,000 miles of new waterways merit serious consideration for possible future development. The total cost of this possible future work would be about $8 billion. The urgency with which this additional construction should be carried out depends upon factors which are difficult to predict. In addition to possible

modifications in national transportation policy, the main determining factors are the growth of transportation needs and the future cost of alternative forms of transportation. At present we can only assume that needs will develop at about the same rate in the future as in the past. On this basis we should anticipate investing about $2.7 billon in the improvement of construction of waterways by 1980.

Also, construction of 14 new deep-draft harbors on the seacoasts and the Great Lakes, and improvement of 46 existing harbors are expected to become justified over the next two decades. The estimated cost of this work is about $2 billion.

The Atlantic coastal storms early this March have emphasized the need for expanded programs to protect against loss of life and property and destruction of beaches along the national shoreline. Without taking into account changes that may occur in Federal legislation and policy, we feel reasonably sure that we will be called on to undertake more shore protection, including hurricane protection projects, than has been contemplated before this year. A very rough order-of-magnitude estimate might be in the neighborhood of $1 billion by 1980.

To get the big, overall, comprehensive water resources development job done on time and economically, we shall have to accelerate river basin planning and project surveys. Increased emphasis is being placed on this 'activity in my own office. And, as a first step in avoiding a bottleneck, special river basin planning units have been established in each of our Divisions. These units will carry on continuing studies of reservoir needs and potentialities for each river basin similar to those prepared for the Senate Select Committee. These studies will help provide the detailed data needed to further refine the estimates of needs set forth by the Committee. They will also help the Corps of Engineers develop more dependable time-tables for providing additional storage capacity, will help locate reservoir sites, and will determine the river flows needed at key points along the main rivers.

We expect our basin-study units to help us cooperate effectively with other river-basin planning agencies such as those recommended by President Kennedy. Pending completion of comprehensive basin plans, they will help us to make sure that our proposed projects will fit well

into future plans and help us give proper consideration to selecting the best of alternative means of meeting resource needs.

Let me repeat that our estimates are necessarily based largely on meeting those requirements for which the Corps of Engineers has primary responsibility. But I might point out that many different water-resource programs tend to converge on those of the Corps, particularly with respect to basic stream flow regulation. our basin-study assignments, from the late 1920% to date; the nationwide scope of our programs, and our involvement not only on rivers but on lakes and seacoasts; the many contacts we have established at community level all overthe United States through both our military and our civil missions--all these bring us into contact with the nation's over-all water-resource needs and problems. And I hope that by telling you candidly how big the job ahead appears to us, it may help organizations such as the National Rivers and Harbors Congress to gear up their own efforts to help get the water resources job done well and on time.

What we are dealing with involves the total future welfare to our nation. Water-resources development must be undertaken not merely because it is profitable, or so that we may live more comfortably. It must be undertaken to preserve our national economy, our security, and our way of life. It is one of the foundation-stones of national defense and of our country's future greatness. No task is more urgent. It is a challenge to us all.

The Dominant Conservation Idea
A Speech before the National Reclamation Association
Portland, Oregon, October 18, 1962

During the 17 months I have been Chief of Engineers, I have seen most of the United States and much of the rest of the globe while inspecting Corps of Engineers operations at home and overseas. On these trips, I have seen much evidence of the series of chain-reaction "explosions" in population growth, technical progress, discontent, and change which are reshaping the world we live in.

From these observations, I have come to appreciate even more the need to push ahead faster with water development to help accelerate the economy right now, as well as to meet the demands of national growth.

While the idea of using water development to help generate economic drive is novel in some parts of the country, it is an old story here in the West. However, it is taking on new dimensions even here. Today, all parts of the country are being caught up in a movement towards full, comprehensive development of water resources undertaken cooperatively by federal, state, and local interests. In fact, this movement is emerging as the distinctive and dominant conservation idea of our time. It reflects considerable change in our nationaal concept of the importance of water conservation, the **size** of the water resources development task, and how best to tackle it.

Take reservoirs, alone. It is expected that about 400 million acre-feet of new storage will be needed less than two decades from now, just to regulate the country's rivers to increase low flows for water supply of all kinds, for water quality control, power, navigation, recreation, and the like. That is an enormous amount of storage; more than all our country has built heretofore; and much of it will be required here in the west.

We estimate the portion of this increased capacity that would normally be built as Corps undertakings would amount to something like $15 billion, at 1960 dollars. That portion of it to be built in the West would provide more water and power for expanding your irrigated economy, in addition to other benefits. Some of this increased storage already has been placed in construction since the figures were compiled, and

preparations are being made to get more of it underway. It is our policy to plan the systems and structures in such a way as to make maximum contributions to the reclamation program wherever this can be done.

Of course, the reservoirs are just a part of the comprehensive development task, though a key part. When we try to size up the job projected by forecasts of national demands, including water supply, flood control, navigation, power, and other purposes, we find ourselves contemplating Corps programs in the next two decades ranging from $1-1/2 to $2-1/2 billion a year for new construction alone.

Both the size and the complexity of the task ahead put a premium on ingenuity and efficiency in both planning and construction.

In planning, we must find a way to place more emphasis on long-range needs, without slighting current requirements. We shall have to build for current needs, as we plan for long-range needs. This is always difficult for if planning is not projected far enough ahead, you run the risk that what is built today may block something needed later on.

By and large, I think the western states have fared well with planning and building water developments. Here future development is largely a matter of making use of relatively unimpaired natural advantages. Conservation in the East is often a matter of finding remedies for problems.

One of the significant trends in water development is the growing participation by the states and their subdivisions in the formulation of comprehensive river-basin plans and in construction. Such participation is essential to good development and should be encouraged.

The federal agencies, too, are taking a broader interest in certain aspects of water development, such as recreation, water supply, and water-quality control. Federal assistance can be of outstanding value in helping the states and local agencies expand their activities in these fields. This kind of cooperation is essential if water resources are to be developed and put to use in a way that will best encourage economic growth.

Another recent change in the water resources scene is one for which this association is entitled to considerable credit. I refer to the new standards for

the economic evaluation of projects established in the place of old Budget Bureau Circular A-47. As I am confident you are familiar with these changes, I don't need to describe them to you. But I would like to point out that the new standards must be applied with prudence and foresight. In evaluating hard-to-measure benefits, we Don't want to be hidebound by formulas, but we do want to be sound. And in estimating the productive life of project facilities, we don't want to be myopic, but we do want to be realistic. In the future as in the past, the American people must be able to rely with confidence on the quality of the investment proposals offered them. In a sense, therefore, the more liberal standards mean that we must take greater pains than ever in projecting needs and benefits into the future.

The bigger our plans, the more facts we need to prepare and support them. Thus, we need a much more intensive fact-gathering and fact-analyzing effort, supported by new techniques for handling and using data, to get the most out of comprehensive basin planning.

When we deal with all the water resources of a major river basin, we may often be confronted by a huge complexity of possible alternative patterns of development. Accommodating important, even vital, interests may depend on choosing the right pattern and phasing it in the right time-sequences of work and investment. Modern methods of systems analysis, involving the use of electronic computers, can help us compare alternatives and solve problems on a scale that otherwise would be impossible. So we are thinking of applying such techniques to our water resource assignment. In cooperation with Harvard University, we are carrying out a three-year program aimed at exploring such possibilities. It is possible that they could transform the field of water resource planning.

Still another need is to gather not only masses of facts but a full range of viewpoints concerning resource problems. Actually, interests and viewpoints are facts--facts that help define the social, economic, and political environment in which development will take place. Plans, programs, and projects must be soundly fitted to their human as well as their geographic environments. In dealing with viewpoints, as with any other kinds of facts, the problem is not so much to collect them, as to determine their impact on the end product of resource development. No significant view or interest should be omitted, and none can be permitted to predominate unduly, if we expect our plans to provide a sound foundation for future growth.

In every one of our field divisions, the Corps of Engineers will have planning groups specially charged not only with keeping abreast of changing water needs, but also with keeping in touch with as wide a range of groups and interests as they can. This is an exacting task, made more difficult by the chronic shortage of trained, experienced planners. Nevertheless, we should make every effort to have comprehensive surveys completed or underway in every major river basin in the United States by the end of this decade. Moreover, these basin plans must be kept flexible and up-to-date through continuous fact-gathering programs carried out in cooperation with the widest range of interests possible.

While a great deal more might be said about planning, I want to leave time for a few words about construction. Our national capability to build efficiently and economically will be one of the yardsticks that will measure not only how well we can live, but also how safely we can live on this crowded and disputed earth. The cheaper and more efficiently we can build, the greater the use we can make of our water resources. I am confident of our national ability to- increase construction efficiency. At the same time, effort should be placed on generating new ideas, and on developing new methods, new materials, new standards of efficient management and techniques for achieving increased construction efficiency, plus an approach that reasonably recognizes few barriers as insurmountable.

For example, the Corps of Engineers is now considering the possibility of linking waterway navigation systems in separate river basins together by cutting open channels through the land masses that divide watersheds. This involves a massive carving up of the earth's surface on a scale that has not been previously attempted.

To facilitate such undertakings, we are now working with the Atomic Energy Commission to explore the possibility of using the might force of nuclear energy in an effort to cut the costs of excavation. Needless to say, our approach to this idea must be made with great care, and each step surrounded with multiple safeguards. At this early date, we cannot even speculate on the outcome of such research, or how its fruits might subsequently be applied to the various aspects of water development, but if the potentiality is there, and there is a way to harness it, no pains should be spared to find out.

To the extent that more efficient and economical means can be found to move large quantities of earth, or to build a dam, line a canal, stabilize a riverbank, or do any of a score of other important construction jobs, a much better, bigger country can be built. Research to such ends should be encouraged and supported as a highly important element of water development.

As we progress with water development, it is of course necessary to integrate new construction into going programs in an orderly way. The Rivers and Harbors Act of 1962, recently passed by the Congress, will be most helpful. Among the other developments, it authorizes for construction, it provides 31 new multiple-purpose reservoirs for the Western states, aggregating over 11 million acre-feet in storage capacity. Among these are dams such as North Fork on the San Gabriel in Texas, Camelsback in Arizona, New Melones in California, Lost Creek here in Oregon, Wynoochee in Washington, Bruces Eddy in Idaho, Clinton in Kansas, and Kaw in Oklahoma, to name a few.

Further, the new Appropriations Act provides for stepping up the Civil Works program by some 7 percent, including funds aggregating $365 million for the 17 Western Reclamation States. It provides funds for 21 new construction starts and 23 new planning starts on various kinds of projects in these states, including construction money for seven of the new multi-purpose reservoirs embracing storage for various needs.

Also, we look forward to further opportunities to expand development of small water resources projects of various kinds under the new Public Works Acceleration Act. These include flood control projects costing not over $1 million in federal funds, and small navigation projects not to exceed $200,000, which I am empowered by law to authorize for construction. Further, we have a number of small projects already authorized by the Congress which may be taken up on short order. Also, recreation facilities may be provided under this act, and we may accelerate, improve, or rehabilitate existing projects.

I would like to add one more thought in closing. We of the Corps of Engineers look to you of Reclamation to help us realize the full measure of benefit from our western programs. On the Missouri, the Columbia, in Texas, in California, and in many other regions and river basins, we have undertakings which are already serving considerably, but which can serve even more to

help increase the productivity and prosperity of the West through joint action. I hope that in the future we can find more and more occasions to work together in this way--more opportunities in which together we may achieve greater benefits from our endeavors.

I thank you.

The Role of Construction in the Space Age

A Speech at the Conference on United States Government Construction Contracts
Washington, D.C., November 6, 1962

Professor Nash, Mr. Keiser, distinguished guests and participants in this conference on Government Construction Contracts. George Washington University% National Law Center and Federal Publications, Inc., are to be commended for sponsoring this symposium devoted to a study of mutual problems affecting construction contractors and Federal contracting agencies.

As all of us know, the Federal Government is the country's largest purchaser of construction services--buying many billion dollars worth annually. If for no other reason, the extremely large cost to the taxpayers, alone demands that all of us in the Federal construction agencies make certain that the American people receive the highest quality work for the lowest possible price, and on time.

Construction, one of the most complex and vital areas of Federal activity, will become even more complex in the age of space. Our jobs will include some of the most demanding ever tackled. In the aggregate, they will be the costliest since the World War II construction task. They will include some of the most difficult, technically, since the Manhattan District produced the original "A-bomb". New techniques, new materials, new conditions of many kinds will be involved and the job will have to be done under the pressure of American growth requirements, national defense, and "The Race For Space2

All three elements directly concerned - the Government, the construction industry and American labor, face the necessity of thoroughly reviewing and revitalizing our ground rules. All of us must look far ahead to anticipate problems and come up with effective answers when they are needed - not after setbacks are experienced: preventive foresight - not corrective hindsight:

Let us enumerate some of the major areas of expanded Government construction.

First, is the newest program to support Space Exploration. While the program can be visualized now only

in barest outline, it looks like at least a half-billion-dollars-per-year construction job.

Next is the Civil Defense Shelter Program - this nation may be facing a program which could eventually involve many billions of dollars of construction, partly financed by the Federal Government, but largely financed by the private sector of our economy. In executing the current National Fallout Shelter Survey Program under direction of DOD, which, of course must precede any large scale construction of new shelter, I think it significant to mention that the Corps of Engineers has teamed upwith the Bureau of Yards and Docks so that this effort from the beginning will be a joint Army-Navy effort.

Then, we must catch up with the backlog of water resources, highways and other communication needs - in themselves "headline jobs" of unprecedented scope and size.

Defense construction will in all probability continue to be extremely large - with prospects for new elements such as antimissile missile construction to be considered.

After that comes the country's more ordinary construction jobs, which I need not enumerate here.

Thus both survival and progress will be measured by what we build. The volume and type of Government construction reflect areas of national importance which demand the earnest attention of architects, engineers and contractors and more than a score of Federal agencies.

Let's take a look now at some of the construction implications of space. Early in 1946, our principal achievement in probing space was reported in page-one headlines which told how the Army Signal Corps had bounced a radar impulse to the moon and back. The United States has come a long way in the past 15 years. To the point, in fact, where President Kennedy has now called for an all-out national effort to land men on themoon and return them safely before 1970. We now stand on the threshold of manned-space explorations the way Spain did over 450 years ago when men began to claim that the earth was round and Columbus set out to prove it. But that's where any similarity stops.

Before our Space-Age Columbuses can take off many theories will have to be put to the test here on earth. Along with the scientific advancement of space flight

engineering, the full capabilities of the construction industry must also be brought into play to provide the research, development, test and operational facilities for space vehicles, their boosters and guidance systems. Thus, the first leg of the journey to the moon will be right here on the ground, and we of the construction game have to accelerate our efforts before science can set out to overcome the pull of gravity.

I would like to point out here that while the space age has brought with it demands for more specialized construction, Federal agencies have not lessened their efforts in seeking improved methods for carrying out more conventional building programs. Our sister agencies, many represented here at this two-day conference, are working closely with engineers and contractors in attempting to apply new solutions to old problems which touch every phase of construction engineering--from small, single-family homes, to the giant multi-purpose water resources development projects. While I may call upon my own personal experiences and those of the Army Engineers, I am certain the thoughts and comments I express here today are equally applicable to the engineering and construction efforts of the GSA, Bureau of Yards and Docks, NASA, Air Force Civil Engineers, Bureau of Reclamation, Bureau of Public Roads, AEC and VA.

The National Aeronautics and Space Administration (NASA) has recently asked the Corps of Engineers to expand its support of the space program by performing major engineering and construction for new space projects, including the manned space flight projects.

Working under this arrangement, and with design criteria furnished by NASA, the Corps of Engineers will supervise the architect-engineer contracts for design and the prime contracts for the building of these projects. We have already worked in this field by providing engineering and construction support to NASA and its predecessor organization on several jobs.

While many details on this program are still lacking, we do know that the first Saturn rocket was successfully launched at Cape Canaveral, Florida week before last and that preparations are well underway for additional Saturn and other large boosters to be launched from that facility. In order to prepare for these shots, 73,000 additional acres will be developed atthe cape, including many new launch complexes. We are currently engaged in acquiring the real estate for these projects which will

increase the present size of Cape Canaveral more than five-fold. Cost of additional land alone will total approximately $60 million.

Plans call for these launch sites to be widely dispersed and far from habitation for safety reasons and because the boosters will be the largest ever developed and the noise generated by them will be earsplitting. Simultaneous with the construction of these new launch facilities a completely new Manned Spacecraft Center will be built at Houston, Texas, for the design and testing of space vehicles and their crews. In conjunction with these activities, powerful liquid and solid fuel rockets for the Saturn and Nova projects will be tested at other facilities yet to be constructed in Southern Mississippi and Louisiana. These new centralized test facilities and support items are currently estimated to cost some $300 million and will include the intricate control centers, and the static and dynamic test stands necessary for the captive firing of boosters and second-stage rockets.

In accordance with the announcement by NASA last month, the U.S. Army Engineer District in Mobile is taking action to acquire or obtain easements an 141,000 acres in Southern Mississippi and Louisiana with access to the Pearl River.

It is important to the space construction program that these facilities be built on sites located on or close to our navigable inland and intracoastal waterways. NASA wants to place new facilities on the waterway because many of the future boosters will be too heavy to ship by air and too large for existing railway and highway bridges. Earlier this year, the first Saturn booster was transported from Huntsville, Alabama, to Cape Canaveral via barge. Thus we see that the space age where speed is measured in 10's of thousands of miles per hour is firmly attached to speeds of 4 mph on our waterways.

Our engineering and construction industry is ready for the space job. Working together, the Corps and industry have had considerable experience designing and building research and test facilities at the White Sands Proving Ground in New Mexico; fabrication and test facilities for both the Army Ordnance Missile command and the Marshal Space Flight Center at Huntsville, Alabama; as well as launch pads and service towers at both Gape Canaveral and Vandenberg Air Force Base in California. And just as they did in building for production of the first "A-bomb"

under the Manhattan District, construction contractors have proved themselves highly competent to take on revolutionary new tasks and execute them fast and effectively. Within a relatively short learning time the industry has seeped into the billion-dollar ICBM base programs and has acquitted itself well in the handling of a pioneer job of an exotic nature. In these new assignments the industry has taken the lead in developing techniques and methods for working with new concepts and material.

The compressed time frame of the new space program, as well as the new and highly technical requirements, demand the highest sense of responsibility on the part of all interests concerned. The Corps will necessarily have to be discriminating and extremely strict in qualifying bidders, in the inspection and acceptance of work, and in other matters of contract administration. Contractors and labor will have to establish their own volition, new standards of responsibility for quality and speed of work. All of us must look ahead - to devise the techniques, equipment, skills and materials that will be required.

In support of improved construction techniques and materials for highly specialized work such as this, the Corps of Engineers is carrying on basic research within its own laboratories and by contracts with top research and engineering organizations. We are constantly probing as far as we possibly can into materials, the design of facilities and structures, equipment and construction problems.

The current work in building ICBM bases for the Air Force will contribute much to the industry's capability to carry out space age construction efficiently and economically. The ICBM Construction Office at Los Angeles, under operational control of the Air Force Ballistic Systems Command, CEBMCO, was given one job to do -- build the missile bases and do it well, economically and fast.

The Office of the Chief of Engineers, down through the Divisions and District offices, as well as all other appropriate units, are continuing to give required support to CEBMCO and the ICBM construction effort.

The same support is now being marshalled with the Corps to give the stepped-up space construction program of NASA its needed boost.

Most of the space test facilities will be built for vehicles still under development and therefore design change orders can be expected, as in the ICBM program. Architect-engineers and contractors will have to shoulder heavy responsibilities for the speed with which the total space program moves forward, because much of the initial efforts will depend on the construction of basic research and test facilities.

The industry has a tremendous opportunity and should start preparing its internal organization to expedite the work put in place. General contractors must, early in each job, set up machinery with their sub-contractors to work out anticipated problems. I urge all prime contractors to agree on procedures with their contracting officers ahead of time so that when they come to them with substantial changes in a facility's design, resulting from modifications in the space hardware itself, construction can go forward without a break.

One of the advantages of such an approach will be to provide both the Government Contracting Officer and the contractor with an opportunity to work out their differences in the field - at the place where the problem arises and at a time when the facts are readily obtainable and positions have not yet become solidified. Talking problems out at this level should most certainly reduce the number of claims that will have to be fought through a time-consuming process of the Appeals Board and the courts, and work to the mutual advantage of everyone.

Another important area where improvements can be made is in the field of labor relations. Jurisdictional disputes make up one of the more sensitive areas of labor relations and much can be done to improve past records. Space construction will present many union jurisdictional questions involving installation of new and highly complex equipment, new construction concepts, and other matters. Let's look ahead on these potential trouble spots and cure as many of them in advance as we can so interruptions of work can be avoided. With both labor and industry eager for us to win the space race, it's primarily a question of foresight and good management on both sides to keep out of misunderstandings and trouble.

In' the past on certain types of NASA construction, our District Engineers have found it necessary to prequalify contractors and subcontractors bidding on the work. This practice will doubtless be continued as necessary - with the approval of my office and NASA. Prequalification

will not be used in every case, however, but rather when the particular nature of the work seems to call for it.

The criteria for prequalification of contractors include: experience, past work performance, equipment and facilities, integrity, contract administrative ability, and availability with respect to existing workloads.

From the overall point of view, prequalification will assure that the NASA construction program will be carried out by the lowest qualified bidders, to the benefit of all concerned--the construction industry, the using agency and the public.

The construction industry has a unique role in space construction and its capabilities must keep pace with the ever changing requirements of the design engineers. At times even before the general contractor completes the basic construction, it is necessary for the hardware manufacturer to begin installing highly technical instrumentation equipment. At this point in the past, disputes have sometimes arisen and the work stopped. We must see to it that there are no such shutdowns and that the work schedule proceeds in an orderly manner, and without a break. The construction contractor must prepare for and effectively handle the transition from construction to operation equipment installation by others.

The general contractor can be expected to play an increasingly important role in Space Age construction. In fact, heavy construction calls for a type of on-the-job ingenuity in meeting whatever conditions the Vagaries of nature or man may present which are not usually encountered in the more closely controlled environment and work conditions of the laboratory or production line.

The day-to-day competition between construction contractors breeds a type of resourcefulness that is of great value in getting a job such as Space Age construction done.

We know that when the time comes to bid, individual contractors will come forth and pit their firms and reputations against all comers. When the work is especially large or complex, joint ventures will be formed giving the Federal Government a combination of specialists, who are masters of their own particular

trade, in excavations, foundations, concreting, steel, erection or other specialized work. These individual firms, when teamed together, will assure us the highest degree of capability.

Since the construction tasks for support of space exploration present the most difficult assortment of problems, I have dwelled at length upon them. I do not want to minimize, however, the continuing problems that all Federal construction agencies must meet in defense construction, in water resources development, or in other fields I mentioned earlier.

I am sure that the heads of all the other Federal construction agencies represented here today will agree with me that we and the construction industry must find a way to get the most for the dollar. The demand on the limited number of taxpayers dollars for the many vital programs will be great. The public, their representatives in the Congress and in the Executive Branch will look longer and keener at each dollar - to get full worth from it. The scope and objectives of these programs must be kept realistic, and I think they will be. The construction industry and agencies such as the Corps of Engineers which employ them will be in the constant spotlight of public scrutiny.

The forbidding conditions and the unknowns we faceare only challenges to be met, just as we do when soil conditions encountered in digging an ICBM silo differ from what the test borings showed, or when the geologists fail to find a thin fault in the foundations of a dam, or we have to build defense bases on snow, ice or permafrost in the remote Arctic. There have been. periods when the obstacles seemed overwhelming, but as long as the engineer and the builder and their workmen take the initiative to find the ways to do their jobs, whatever they are, and acquaint themselves with the problems of their fellow men, they will continue to keep their independent place among the leaders who contribute to the security and development of our way of life.

This, then is the challenge that confronts us, whether constructing ICBM bases, space flight test facilities, or carrying out basic research that will let man safely explore the moon and the planets beyond. I am confident that the construction industry will do its job well.

Remarks at the Engineer Instructors Conference
Fort Belvoir, Virginia, July 24, 1964

I have been looking forward to this chance to speak to you. It has been two years since I addressed the Engineer Instructors -- and a lot has happened since then.

When I last spoke to you, we in OCE were still in the throes of reorganization. At that time, we forecast that the impact would scarcely be felt in the field. Most of the changes would be in my office.

And so it was.

We lost the direct operational responsibility for training, doctrine, Research and Development, personnel management and Engineer Supply. We retained the functions of Topographic Mapping, Military Construction, Civil Works and Real Estate.

OCE's relationships with the Department of Defense remain about as they were. As the Engineer advisor to the Chief of Staff of the Army, I have an official hunting license which allows me access to those activities which we now monitor instead of controlling directly. We consult, advise and do anything else necessary to improve the Corps' combat readiness.

The Corps remains a full-fledged combat arm. OCE's major military efforts now emphasize formulation of policy, planning and conducting an aggressive monitorship of all matters related to military engineering. To carry out this monitorship we have our Directorate of Topography and Military Engineering which keeps in close touch with the DA staff, unified and specified commands, Army Commands, schools, field armies, MAAGs and Missions -- wherever there are Engineer activities.

General Hayes, who runs T&ME, has the Directorate organized into three major divisions: Mapping and Geodesy, Topographic Sciences and Military Engineering.

The first two divisions look after our extensive mapping and geodesy missions including the activities of AMS, GIMRADA, the 64th and 30th Topo Battalions, the SECOR satellite program and other systems which enhance these fields. As you know, we have mapping activities going on in over 50 countries.

The Military Engineering Division keeps abreast of such things as the engineer phases of Civic Action and construction support to the Air Force; it recommends changes in troop organization, training and engineer doctrine; and it maintains close liaison with STRICOM, CONARC, 11th Air Assault Division and other agencies or activities where our monitorship will aid our defense posture.

Another interesting activity in T&ME is the Engineer Strategic Studies Group -- a very active outfit which plays a vital role in the creation of many high level Army staff studies. Some of its work has to do with the planning for a type Corps Force for use in Asia; PAMUSA, the role of the Army in post attack Mobilization; CDC's "Oregon Trail" study of Tactical Nuclear warfare; and other studies of equal strategic importance. This Group has entry into all the high level places. It shapes a great deal of the strategic thinking in all fields of endeavor of the Department of the Army. And, of equal importance to you and me, is that the work of this Group insures that in these high level studies Engineer planning is not being overlooked.

All of the people of T&ME -- indeed, all of us in OCE -- are ready to go anywhere or do anything to improve the combat effectiveness of the Corps. Along this line -- I look to you gentlemen to keep our brother services informed of our great interest in our combat functions, and our developments in them. I hope you will keep well informed yourself. T&ME operates quite informally; feel free to visit, phone or write for any assistance that may be useful to you.

In the nearly three years I have been Chief, I have travelled over 300,000 miles and visited scores of Engineer organizations, projects and exercises. You might be interested in some of my observations.

Aside from being a combat arm, we are the largest construction agency, real estate operator, and mapping organization in the world. We are also the Nation's largest developer in the field of water resources.

Our Civil Works program in the fiscal year just ended reached about $1.2 billion. We expect it to increase for a while at the rate of about five to six percent per year.

Our annual real estate expenditures are about $160 million for the acquisition, disposal and management of

approximately 36,000,000 acres of land around the world for the Army, Air Force, AEC, NASA and many other clients. To illustrate a typical real estate operation -- Exercise DESERT STRIKE, last spring, required our negotiation of some 4,500 separate permits for lands in three states involving about 12,500,000 acres.

Our design and construction support for NASA's Manned Lunar Landing program is another of our large and challenging activities. During the last fiscal year, we placed more than $300 million worth of construction for NASA in locations such as the spaceport at Cape Kennedy, the Manned Spacecraft Center at Houston, the Mississippi Test Facility and other NASA installations throughout the country.

We continue to study problems associated with construction of a base on the moon. We have just published a 1:5 million scale map of the visible side of the moon and hope, ultimately, to enlarge this scale to 1:25,000 for more detailed use by our lunar explorers.

Our Civic Action program is a booming one. Almost every nation in South America and dozens of others throughout the Free World enjoy some sort of Civic Action program and we help the DA staff and field agencies to shape them up.

Paralleling Civic Action somewhat is the overseas construction our Districts and Divisions accomplish upon various requests by the Agency of International Development. We've built airports for Iran and Pakistan, an air terminal for Saudi Arabia, a highway for Afghanistan and are working on other major construction for these and other countries.

A.I.D. frequently calls upon us also for studies, surveys, designs and consulting services. In this activity, we have dozens of engineers in the field working with countries such as Egypt, the Congo, India, Jordan, Australia, Greece and scores of others.

Many benefits accrue to these nations under both the A.I.D. and Civic Action Programs. They become more self-sufficient economically and militarily, as we leave behind us improved public works, trained manpower and a developing awareness of technology.

Benefits also accrue to us through the promotion of international friendship, increased foreign trade and the enhancement of our national prestige.

of equal value is our accumulation of a wealth of foreign area information and the creation, in effect, of a large group of foreign area specialists within the Corps of Engineers.

My wanderings have also brought me in contact with our problems in providing engineer troop support for the Air Force. Our support requirements for Tactical Air Commands under CINC MEAFSA are going to be heavy. I am pleased to report that we and the Air Force are getting along well together in our mutual effort to improve our capabilities in this potentially vital role.

I was down at Benning a few weeks ago to visit the 11th Air Assault Division. Things are going well there and I'm looking forward to seeing our 127th Engineer Battalion in action during the Division's field tests coming up in September. We've been working closely with the 11th Division. Jointly, we have developed some fascinating concepts of air assault construction support. It will be interesting to see our theories in practice.

We have made a lot of progress in the ADM business. Three ADMs have been eliminated from the system, including the two most cumbersome ones. We are looking forward hopefully to the development of the AND - the Advanced Nuclear Demolition.

With these better munitions, with the ADM platoons just authorized for stateside combat battalions, and with a much needed speed-up of the weapon delivery cycle, we will have a truly advanced nuclear capability.

I spent some time recently observing the joint Exercise DESERT STRIKE. Those 12,500,000 acres I just told you about allowed two Corps to manuever against each other over a front as wide as 150 miles. That's a lot of front, particularly for a two division Corps making an assault river crossing. Obviously, our engineers worked like the devil. There weren't enough of them, but they worked hard. Many of the uninitiated were happy about the situation, but those of us who are old hands know better. These troops obviously lacked opportunity to receive proper training.

Here are some of my thoughts on **DESERT STRIKE:**

1. Planning for engineer troop support was inadequate .. perhaps from a lack of appreciation by the general staff planners, incurred by inadequate Engineer representation during the planning phase. The old rule of thumb of "one Army combat battalion to back up each Division" and similar planning cliches just won't do any more. A campaign or a battle is now so complex with its alternatives in size, speed, weaponry and mobility that each Engineer Plan should be flexible, custom-tailored job accomplished by a real "pro". I am afraid the Army's preoccupation with "functionalization" has caused a trend toward Staff Engineers disappearing or losing identity by being absorbed by G-4s, etc. I feel that there is now, more than ever, a need for an identifiable, full-time Engineer section on every staff from the division to DA, and I shall continue to say so and to fight for such an Engineer Section on. every occasion that presents itself.

2 It was apparent that the stateside Divisions need more training in river crossings. so do our battalions and bridge companies. It takes a lot of practice to maintain the skill and teamwork required for supporting a river crossing. While on the subject of training, or lack thereof, I'd like to mention an imposition upon our training time which must be carefully controlled. My visits to Engineer units reaffirmed that the morale and skill of fine outfits can easily go down the drain through misuse by the Post commander of other non-Engineer authority. While many post projects do provide splendid individual and unit training, many others do not. I have seen good battalions used as a labor pool, as stevedores, as police and maintenance details and in other "dog-robbing" roles whose value-of-the&moment could never compensate for the great harm done to these previously splendid organizations.

3 **DESERT STRIKE** pointed up either a disinterest in or the lack of awareness of, the value of obstacles and barriers. Barriers were shallow; obstacles were seldom covered by fire; few troops other than engineers seemed to use or know anything about mines in either offense or defense.

4 Camouflage and concealment was very poor. while our camouflage materials are pretty poor, we can still make better use of them than we did. And there is a lot that can be done with regard to better site

selection, better dispersion and old-fashioned camouflage discipline.

I am continuously impressed with the thought that in spite of our rather exotic equipment the things which cause us Engineers the most trouble today are the same ones that have plagued us for as long as there have been engineer troops. I can easily visualize Richard Gridley or Rufus Putnam composing the following cliches for delivery to his commanders and Engineer Instructors:

1. Those are Engineer soldiers -- don't dull their sharpness by work that any soldier can do.

2. Get the other combat arms to assist you in denial operations.

3. Make sure the commanders from Brigade, up, know exactly what your capabilities are.

4. Try to influence the awareness of all to the use of camouflage, concealment and dispersion.

5. There is a need for better terrain informationand engineer intelligence; this is a function in which all arms participate.

6. River crossings are slow, requiring careful planning, much equipment and prodigious Engineer effort.

7. Exercise intellectual curiosity -- keep abreast of *things and inform others of your knowledge. Encourage a cross-fertilization of ideas amongst all whom you influence.

8. Keep in touch with the home office.

9. The Trained Live . . . The untrained Die.

Can you think of many new ones?

I have followed with great interest your agenda of the past four days. I hope it has been equally interesting to you and that it has provided you with much sermon material to enhance your missionary work for the Corps.

To your captive congregations, I hope your preaching will at least cover the following matters right out of the bibles of military engineering:

1 That the ability to walk on water has been a lost art for over 1900 years. Water barriers must still be crossed the hard way. While river crossing means and techniques are steadily improving, any combat crossing is a major task and is one which, unfortunately, is frequently underestimated by commanders. Make sure that you continually preach that river crossing operation planners must call upon Engineers for advice and that this advice must be called for right from the initiation of ideas for the crossing. Such plans must be based upon engineer capabilities, and must provide for adequate support plus a reserve for contingencies. Come to think of it, this applies to almost any type of operation -- not just river crossing.

2 Do not neglect camouflage. It is as important today as it ever was. So are barriers.

3 Commanders must not become complacent or overly patronizing over the Army's new mobility gadgetry. The Army has developed quite a few new and sophisticated means for driving to work, but real mobility for the Army as a whole, truly still begins and ends with the Engineer. Our new craft and vehicles indeed allow us to cover more geography sooner -- but this simply means that the commander will meet many more obstacles for his Engineers to bridge, to clear, or to bypass. A good deal of these improved mobility means create in themselves, vastly increased requirements for Engineer effort. And -- the same increased mobility on the part of the enemy makes a barrier and denial operations more difficult and a matter of true concern to every commander and soldier, on, or behind, the battlefield.

4 There are many blessings which flow to the combined Arms Commander who knows his Engineers' capabilities -- who uses them wisely, and who constantly thinks about and provides for the necessary Engineer means.

5 And there is woe that befalls the Commander who does not.

Remarks Before the Senate Committee on Public Works, Subcommittee on Flood Control and Rivers and Harbors Washington, D.C., March 22, 1965

Mr. Chairman and Members of the Committee:

As you know, I am approaching the end of my term as the Chief of Engineers of the United States Army, and also the end of a 36 year career in the Corps of Engineers. Under the circumstances you will, I trust, forgive a brief backward look on my part; not because I am particularly nostalgic about my own career, but because it happened to have spanned a period of revolutionary change in the Nation's approach to the development and utilization of its natural resources. During that period all of us have, I believe, learned many lessons and gained much perspective. It has seemed to me that those of us who have been closest to the Federal Government's efforts in this field should share our perspective with those who will be confronted with the increasingly important, and increasingly difficult, problem of meeting the Nation's rapidly growing need for the development of its water and related resources. For it has truly been said that "past is prologue/

When I began my Army career as a Second Lieutenant, fresh out of West Point in 1929, the Corps of Engineers had two main responsibilities in the civil works field: the design and construction of navigation works, and the carrying out of a great project -- which had been authorized only the year before -- to harness the Nation's greatest river, the Mississippi. The Federal Government had not yet accepted a Nation-wide responsibility for flood control. That was not to come until 1936 when the Congress enacted the first general flood control legislation. Today, the Civil Works Program of the Corps encompasses not only navigation and flood control, but also the generation of hydro-power, the provision of water for municipal, industrial and agricultural use, the storage and release of water for the improvement of water quality, the drainage of wet lands, the enhancement of the fish and wildlife resource, the development of the vast recreational potentials of the projects by which these ends are achieved, and the preparation of comprehensive river basin plans. And since I began my career the annual appropriations for the Civil Works Program have increased from less than 100 million to well over a billion dollars. This striking change has, in reality, all taken place in less than 25 years; for during the Second World War and the Korean

conflict all of us had, as you know, urgent business elsewhere.

Behind these tremendous changes were the growing needs of the expanding economy of the greatest industrial Nation in history. These needs will continue to grow, and the Nation's programs for meeting them must continue to grow. But one of the lessons we are just beginning to learn is this: A modern nation cannot be content with merely meeting needs as they develop it must use its public works programs as a means of accelerating the growth of the economy, and of enhancing the welfare of its people. **This is** one of the fundamental ideas that should, in my opinion, guide this Committee in its future deliberations.

As the Civil Works Program has broadened in scope and increased in magnitude there has been a fundamental change in the nature of the problems we have been called upon to solve. Let me illustrate what I mean.

When I first began to grapple with the problems of resource development, our main concern was with the investigation, design and construction of individual projects; and quite often these projects served but a single purpose. Looking back now I can see that we didn't appreciate what an easy job we had then. Today we must plan for the comprehensive development of major river basins, and our goal for each basin must be a plan that will, in the long-run, make the most of all of its resources. This requires us to consider all of the alternative uses to which these resources could be put, and all of the alternative ways in which they could be developed. The single-purpose reservoir has become virtually a thing of the past. The multiple-purpose project now dominates water resource development. Planning has been revolutionized and has become immeasurably more difficult. No longer is it a matter of finding a site, designing a structure, and then building it. Our first concern must be to discover that combination of projects and programs which will make the greatest long-run contribution to the wealth of the Nation and the welfare- of its people; keeping always in mind that whatever we invest in such projects becomes unavailable for meeting other urgent human needs. In modern planning, therefore, we must utilize the know-how of experts in many fields. Economists, agricultural experts, specialists in recreation, biologists, and professional people in still other fields have important roles to play. Moreover, river basin planning has become a cooperative undertaking in which the various agencies

able to make important contributions must work together in close harmony in formulating a truly comprehensive and unified plan. And once such a plan becomes available it must be used as a guide by all of the agencies concerned.

Comprehensive and coordinated development of major river basins has been urged since the time of the "Conservation Crusade" led by President Theodore Roosevelt. Many commissions and other similar bodies have, during the ensuing years, supported the concept. The most recent, and probably the most effective, of these was the Senate Select Committee on National Water Resources. The report of this Committee constitutes a landmark in the Nation's efforts to achieve more efficient use of its natural resources.

The Select Committee's recommendations were embodied in the Presidential Standards issued by President Kennedy in 1962, and these Standards were printed as Senate Document No. 97. A happy conjunction of the report of the Select Committee, the Presidential Standards, and the provision of an adequate legislative base by Acts of Congress over a period of many years, has finally made it possible for the Federal Agencies, working with the States, to provide the kind of comprehensive river basin plans called for by President Roosevelt at the beginning of the present century. I count myself fortunate to have lived through this period of fruition, and to have been able to make some contribution to a development which will mean so much to future generations.

I am convinced that what has been accomplished is a good thing for our Nation, and I earnestly urge this Committee to remain steadfast in its support of comprehensive and coordinated planning for the development of our Nation's great rivers. You are on the right track.

This is an appropriate point to make a comment that has been "welling up" in me for some time. Now that I am about to shift my burden to a new Chief of Engineers, I feel an obligation to mention a problem that will probably distress him as much as it has me. It has become somewhat fashionable lately to intimate that the Corps of Engineers is incapable of doing modern comprehensive planning . that we are interested solely in building engineering "monuments." It is my hope that my brief recitation of the revolutionary changes that have taken place in Corps planning during my own career will convince you that the Corps is capable of adapting its planning to the needs of a modern industrial economy. In fact, . believe that the Corps of Engineers has donemore

than any other single agency actually to put into effect the kind of comprehensive planning which far-seeing men have advocated for many years, and which the Senate Select Committee so recently commended. Our basin planning program began as long ago as 1927 when the Congress authorized us to develop the so-called "308 reports." These were the first comprehensive plans to be submitted to Congress by any agency, and they constitute the basis for some of the great river basin programs now being carried out. Progressively over the ensuing years we have improved our planning. An example of a modern comprehensive plan is that developed for the Delaware River Basin under Corps leadership. This plan has come to be considered a milestone in the progress of river basin planning. It was authorized by the Congress, and is now being carried out by several agencies of the Federal Government, the States, and the Delaware River Basin Commission established by an interstate compact. We are presently participating in the development of comprehensive plans for a number of major river basins throughout the Nation.

Our accomplishments can speak for themselves. I should like to summarize them for the record. Through the Civil Works Program the Nation has been provided with about 500 commercial harbors and an inland waterway system comprising about 22,000 miles of waterway. More than 300 reservoirs have been built or are under construction. For flood control thousands of miles of levees, floodwalls and channel improvements have been constructed. The hydropower installations of the Corps have an aggregate capacity of 8.8 million kilowatts. At our multiple-purpose reservoirs we have provided 2.3 million acre-feet of capacity for the storage of municipal and industrial water. At those projects where records of recreational use are maintained -- and this does not include all of our projects -- we logged the amazing total of 156 million visitor-days in 1964. We are increasingly providing reservoir capacity for the storage of water to be used for quality control. We have built projects to protect hundreds of miles of shore. In many instances our channel improvement projects have enabled rich lands to be reclaimed by drainage. Other projects of a more specialized nature have also been carried out under the Civil Works Program. I am proud of this record and I believe that this Committee has a right to be just as proud as I am.

Despite all that has been accomplished in bringing the Nation's rivers under control and in developing their waters for use, we are, I believe, still in the initial

stages of river basin development. The experiences of the past twenty years convince me that one of the great problems confronting the Nation is the regulation of its rivers for all purposes: not just to reduce flood or to improve navigation, but also to assure adequate dry season flows for future industrial and urban development, to maintain a quality of water compatible with such developments, and at the same time compatible with recreational use and the continued existence of our fish and wildlife resources. This will require the planning and construction of great systems of regulating reservoirs in our major river basins. This is a job that the Corps of Engineers can, in my opinion, do better than any other agency. And this is the great task of the next several decades.

I would be derelict if I did not express to you my concern on the subject of basin monetary authorizations. Two years ago for the first time in history a Chief of Engineers found himself in the unfortunate position of stopping some contractors in mid-stride, where although project appropriations were in hand, basin authorizations would be exceeded if expenditures of available funds were not stopped. This resulted in inefficient use of our means and resulted in placing both the Administration and the Congress under the gun. Since that time, I have assured that contracts are not initiated unless there are both funds and authorizations available sufficiently far ahead for Congress to give deliberate consideration to these requirements. General Graham will present the situation on those basin authorizations which are again approaching the limit on our capabilities. I urge sympathetic consideration and early provision of additional authorization to carry us forward at least three years.

I also bespeak your continued support of a program which the Corps was authorized to undertake after its objective had received the strong support of the Senate Select Committee. I refer to the program under which we provide a flood plain information service. This is an important Federal contribution toward better use of the Nation's flood plain lands. It provides the States and their subdivisions the expert assistance they require in regulating the use of their flood plains. I look for this program to yield important results in the years to come.

I should like to close this statement by thanking you, on behalf of the Corps, for the kind and generous consideration that we have always received from the Congress.

Remarks at the Engineer Dinner
Fort Belvoir, Virginia, April 23, 1965

Some of you who are old enough may recall how in the final act of the play, "You can't Take It With you," the grandfather arose to address the annual family dinner. His lines began, "Well, here we are again."

Well, here we are again, at a family gathering for the Engineer Officers available in the area. For you, it is another Engineer Dinner, another chance to renew friendships and to make new ones. For this grandfather, it is all this -- and more too. It is one of the last speeches in the last act. It is one of the highlights of a long journey -- 36 years of traveling down what has been the main highway of life. Now, I'm giving the turn signal to move off on a side road where the traffic will be lighter, the way smoother and the grades easier. However, I know it will be neither as exciting nor as satisfying as the road I've been traveling.

Several years ago, when I began thinking about the inevitability of this evening, I had some qualms about the kind of organization I would be turning over to my successor. I was concerned with the effects of the Army headquarters reorganization on the Corps; concerned with the Corps losing its place and identity in the Army, and I was concerned that the assignment, handling and development of our personnel would suffer.

Tonight those qualms no longer exist. I am proud of the organization I am turning over to General Cassidy. The Corps' image has never been brighter; it commands the respect of the American public, our sister services, and the other agencies of Government. The proof of the pudding is in the fact that General Cassidy was nominated and confirmed to three stars at the outset of his term, and there will be no waiting -period after he assumes the office of Chief.

Since becoming the Chief of Engineers four years ago, I have travelled almost 400,000 miles -- over half of that during the past two years. I have seen the Corps and its people across the world in every type of mission and in a wide variety of jobs. At every major installation under my command I have been proud of our leadership. Even more important, at every major military organization I have visited, the commander has been outspoken in his praise and confidence in his engineers. Additionally,

Engineer officers, are holding many key and unusual positions in the Army and Department of Defense. Let me -enumerate a few who are filling or recently filled some of these posts:

Lt General Starbird is the director of the Defense Communications Agency; Lt. General Ely is the Deputy Director of Defense Research and Engineering; Lt. General Lincoln is the DCSLOG of the Department of the Army; Major General Lampert is the Superintendent of the U. S. Army, Europe; Major General Oberback is the Director of Operations of the U. S. European Command; Brigadier General Dunn, Deputy Chief of Staff, 8th Army; Colonel Larry Vogel was Chief of Staff of the Berlin Brigade after serving as its Engineer and is now on assignment for the Corps to NASA; Colonel Glasgow is the Commander of the 1st Division Support Command; Colonel Snow is the Commander of an Infantry Brigade. I could go on with a long and distinguished list of Engineers. These, of course, are in addition to those holding key positions with Engineer tinge.

The Commanders of our major military organizations have reason to have confidence in their Engineers. As Governor Al Smith used to say, "Let's take a look at the record":

The 1st Engineer Battalion was the only Army unit of Battalion size to receive a unit commendation from STRIKE command in the Goldfire I Exercise. The 127th Engineer Battalion of the 11th Air Assault Division has been outstanding in its support and the development of -air assault techniques; Engineer units in Alaska were commended for their fine work in the aftermath of the Alaska earthquake last year; the 809th Engineer Battalion is doing an outstanding job in constructing a first class military highway in Thailand, and has been praised by the Chief of Staff; the Engineer units in Korea, even those diluted with KATUSA, are doing excellent work. In Germany, the Engineer units are outstanding with atomic demolitions, on barrier work and with float bridges, all important parts of the tactical commander's plans for the defense of Europe. We have many fine Engineer Units. I have mentioned only a few.

Why is this true? I'll tell you why. Let me give you a few thoughts, gathered over 36 years, which will illustrate why we have a fine organization, and perhaps point the way to the future.

Phe Corps is what it is today -- and will be in the future -- because of its people and how they are utilized. The very name itself makes the Corps unique among military organizations -- and it is also a clue to the reason. It is the Army Corps of Engineers; not the Engineer Corps or any other blank Corps. It is the Corps of ENGINEERS, a grouping of dedicated professional leaders, recognized as such, utilized as such, and handled as such. Any other handling will not do the job.

We succeed because the people we select are good people. We give them the job and the authority to do the job, and pretty darn well let them do it! This accomplishes two things -- as I see it: It frees the superiors from engulfing, time-consuming details and allows them to do their jobs; and it is a "head-stretching" exercise for those juniors, equipping them for bigger and better jobs with more responsibility. And we have found that the good ones flourish and grow. The alternative can only be over-control, "yes" men and a withering of ability and desire.

Let your lieutenants make their mistakes -- as we all made our mistakes -- when they are young -- but be sure you give them the kind of guidance and assistance that will help them learn from those mistakes: It has been said, "Good judgment comes from experience that itself came from bad judgment." Recognize the great talent that our lieutenants and young captains possess these days -- and utilize it. The talent and education they bring with them are better than we oldsters brought along with US when we joined the Army. Experience is what we can give them, and it must be good, responsible experience. Only in that way can we provide the kind of officer described by our Vice Chief of Staff when I visited one of his divisions a few years ago. "All these commanders want these days," he said, "are second lieutenants with 20 years experience."

The young man today who joins us is "gung ho" for exercising and developing his technical skill. My generation has sold them the concept that science and engineering are the key to their future and the future of our Nation. Now it's our job to show them that a Corps of Engineers career will give them that chance to meet the challenges of a world of exploding technology, but you must also demonstrate for them the necessity of developing leadership, a capacity to handle people and to manage major undertakings. A good Corps officer possesses qualities of leadership as well as technical

ability. These qualities, combined with a management capability, are the keys to success within the Army and outside it as well.

Our job is big and it demands much hard work from all of us. But working harder is not the answer alone -- constantly "working smarter" is much more important. And to that I would like to add: "Never lose your intellectual curiosity." In this day and age, no one ever learns too much. See what other engineers nearby are doing. Somebody may be able to offer information or ideas that will help you in your present mission. If it isn't of any help immediately it will certainly be useful later when you have an assignment in that field.

A moment ago I said our job is big and challenging. I think it's going to get bigger and more challenging in the decade ahead. Many friends as well as foes accuse us of forever looking for more work, of being "work grabbers" and "pork barrelers." There is some truth in the "work-grabbers" accusation. We do, and should, continue to look for work of sufficient magnitude, variety and challenge to build and maintain an organization equal to the task of coping successfully with whatever contingency may arise in peace or in war. Only by such work can we sustain our organization and attract and keep the caliber of people we require. Yes, we look for work, for when the work-load decreases, the Nation loses an essential capability. You might remember this in your discussion among yourselves and with others both in and out of the Army. The essentiality of our civil works to the defense of the Nation has been adequately portrayed, affirmed, and has been confirmed at the highest levels. We aim to obtain enough of this and other work to be in the vanguard of Engineering, and to have a capability to meet the problem no matter what it is.

Often times our friends chide us about our "detachment" from the Army in much of our work. This is not really true. In my contacts with the Chief of Staff and Senior Army Officers, I make the point that the Corps and its work is one of the most effective agents the Army has in the field of public and community relations. We are proud of being part of the Army; we wear our uniforms -- even on Civil Works jobs; and we insist that we be known as the ARMY Corps of Engineers.

In many parts of the united States, the Corps is better known than the rest of the Army. In some areas, the terms

Artiy and Army Engineers are synonymous. This can be said to be especially true in those areas where we are planning and constructing works beneficial to the economy or well-being of the. area. I have stated that only two Federal agencies affect the lives of more people than does the Army Corps of Engineers -- the Post Office Department and the Bureau of Internal Revenue, and I dare say we are more popular than the latter.

This contact with the public is of great value to the Army and don't let your Army friends forget it.

We are first and foremost a combat arm, an integral part of the fighting ground forces, and are not only anxious to retain our identity at Corps, Army and Departmental levels, but to make sure that our talents and capabilities are properly utilized. For example, there seems to be a considerable pre-occupation with the matter of "functionalization" these days, and we must be on guard as to application. We in the Corps have no objection to functionalization of supply and maintenance; in fact, we support it. However, this is as far as we can go in supporting functionalization in our work. What could be more functional than military engineering as we now know it in the work of the Corps? Military engineering is a function -- a pure function under one heading that provides an essential "package deal" to the user. To re-group portions of this function outside the realm of the engineer is not functionalization -- it is "fractionalization"!

To eliminate Engineer sections of staffs and to place their responsibilities in other so-called "functional" elements of the staff would break up what I consider one of the purest functional arrangements the Army has had:

I am not going to dwell on the weaknesses that can result from a lack of Engineer participation in the planning and execution of missions, they are many. I will say I however, that many blessings flow to the Commander who has knowledge of his Engineers' capabilities and who uses them wisely -- but he must have someone who can truly inform him of these capabilities and how they should be employed. The Commander must have "packaged advice," directly from the only man whose knowledge is equal to the task -- the Engineer.

The Corps must remain an integral part of the Army. Its troop units must continue to play a dual role of combat and combat support. We in the Corps must also earn and

fill our share of the Branch Immaterial jobs all up and down the line, and we must strive to give our officers the breadth of experience that will pay off in future selections not only as leaders of the Corps, but of the Army and the Department of Defense as well.

I have been talking largely about the uniformed members of the Corps. Remember, in that part of the Corps which I command, we have a marriage of the military and the civilian. It is a remarkably happy marriage. The civilian brings continuity, engineering and scientific skill to the marriage, and provide the bulk of our forces in both contract construction and in geodesy and mapping. Our civilian employees take great pride in being members of the Corps, and a great many of them have their uniforms hanging "at the ready". They do a great deal in training and developing our younger officers.

The military brings to the marriage some important contributions as well. You bring leadership gained through broad experience; engineering and management skills, and not the least important by any means, a change of pace through rotation at frequent intervals that helps to inject new ideas and renewed enthusiasm into the organization.

The Corps of Engineers is a great world-wide organization, but in all modesty, to get a true evaluation of your worth, we have to go back to President Johnson's remarks last September at the dedication of the Eufaula Dam near Tulsa, Oklahoma, and I quote the President: "The building of that dam -- the supervision of that dam -- was by one of the greatest organizations ever known to man -- one of the finest organizations ever conceived and developed by the United States Government -- the Army Corps of Engineers."

Anything I might add to that would be gilding the lily.

At the start of this talk, I mentioned "You Can't Take it With You." However, this is one grandfather who will take it with him. I take with me unique memories, satisfaction and friendships that were made in 36 wonderful years as a member of the U. S. Army Corps of Engineers. And to have had the great, great privilege of being your Chief makes me very proud.